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Vol. II

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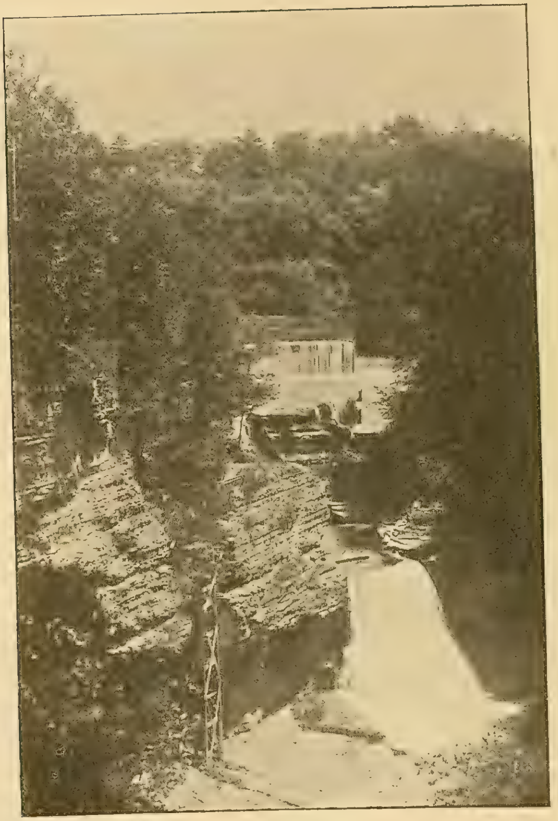

Triphammer Falls.

A typical Ithaca Group exposure.
See pp. 18–19, stations 9, 10, 11.

Photo by J. O. Martin.

Vol. 2

BULLETINS
OF
AMERICAN PALEONTOLOGY

No. 6

THE RELATION OF THE FAUNA OF THE ITHACA GROUP TO THE FAUNAS OF THE PORTAGE AND CHEMUNG

BY

EDWARD M. KINDLE

December 25, 1896

Ithaca, N. Y.
U. S. A.

THE RELATION OF THE FAUNA OF THE ITHACA GROUP TO THE FAUNAS OF THE PORTAGE AND CHEMUNG.

BY

E. M. Kindle.

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PART I.

INTRODUCTION.

The more recent studies of the Upper Devonian in New York have shown that some of its five divisions are closely related to each other by their fossil remains. Some of the most characteristic fossils of one group often begin to appear in the formation just below it, and to continue, though less abundantly, into the succeeding horizon. It is for this reason often difficult to decide whether a group is more closely related to the beds above or below it. In the case of that at Ithaca, opposite views have been held by the two paleontologists best acquainted with it at the typical locality—Prof. Hall including it in the Chemung and Dr. Williams placing it with the Portage.

The present paper has to offer such data and conclusions on the relations which these faunas sustain to each other as the writer has been able to gather from the detailed study of several sections near Ithaca. All of the material collected during this study has been presented to Cornell University and may be found catalogued in the Paleontological Museum.

BRIEF REVIEW OF THE STUDY OF THE UPPER DEVONIAN IN NEW YORK.

The basis of the present classification and division of the New York Devonian was developed by the geologists of the New York Survey—Hall, Vanuxem, Conrad and Emmons—during the first ten years of its existence.

The first attempt to determine the age of the New York Devonian by means of its fossil remains was made by Prof. Jas. Hall, who stated in 1838 that he considered "the rocks of the 4th District as belonging to the Old Red sandstone and the Carboniferous group and to be above the Silurian system of Mr. Murchison."*

Prof. Hall first introduced the term Ithaca group in 1839.† As originally defined by him it included the rocks about the south end of Cayuga Lake lying between the Genesee shale, or Black shale as it was first called, and the Chemung.

In the Report for 1840,‡ Lardner Vanuxem gave the name

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*2d Ann'l Rep't 4th Geol. Dist., p. 291, 1838.
†3d Ann'l Rep't 4th Geol. Dist., p. 318, 1839.
‡4th Ann'l Rep't 3d Geol. Dist., p. 381, 1840.

Sherburne flagstone to the lower part of Hall's Ithaca group. His classification of the Upper Devonian of New York was as follows:—

Tully limestone.
Black shale.
Sherburne flagstone.
Ithaca group.
Chemung group.
Montrose sandstone or sandstone of Oneonta.

In his Report for the 4th District,* Prof. Hall states that in the Genesee valley the Ithaca group and the Tully limestone are wanting. He recognized there the following formations:—

Portage group.
Gardeau group.
Cashaqua shale.
Encrinal limestone.

In 1842 the geologists of the 3d and 4th Districts had reached opposite views as to the relation of the Ithaca group to the formations above and below it. Mr. Vanuxem states † that he had intended uniting the Sherburne and Ithaca groups into one, while Mr. Hall wished to unite the Ithaca and Chemung. Vanuxem, however, retained the original arrangement, only substituting the name Portage or Nunda group which Hall had used in western New York for Sherburne. No distinct line of division is indicated by Vanuxem between the Ithaca group and the Portage below or the Chemung above. In the Report for 1842,‡ Vanuxem introduced the term "New York System" to include all of the New York formations from the Potsdam sandstone to the Chemung inclusive. The following is his classification of the upper part of the New York System:—

Catskill group.

New York System.—Erie division. {
- Chemung group.
- Ithaca group.
- Portage group.
- Genesee slate.
- Tully limestone.
- Hamilton group.
- Marcellus shales.

Prof. Hall united the Ithaca group with the Chemung in the

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* 4th Ann'l Rep't 4th Geol. Dist., p. 390, 1840.
† Final Rep't Surv. of 3d Geol. Dist., p. 171, 1842.
‡ Final Rep't Surv. of 3d Geol. Dist., p. 13, 1842.

Report for 1843 and made the following classification:—

New York System.	Erie division.	Chemung group.	
		Portage or Nunda group.	Portage sandstone. Gardeau flagstone. Cashaqua shale.
		Genesee slate.	
		Tully limestone.	
		Hamilton group............	Moscow shales. Encrinal limetone. Ludlowville shales.
		Marcellus slate.	

Hall states as the reason for uniting the Ithaca and Chemung, the impossibility of distinguishing them by any characteristic fossils. In the valley of the Genesee river Prof. Hall found the three divisions of the Portage distinct and well marked, but toward the south end of Cayuga lake he considered them scarcely distinguishable. He considered the Portage fossils entirely distinct from those above, and states[*] that he never saw one of the Portage fossils in the higher group. As will be shown later, this opinion was due to the lack of an intimate knowledge of these faunas.

The classification of the Upper Devonian in eastern New York has been attended with much difficulty. The absence or scarcity of fossils in much of the series in that part of the State made its correlation with the well defined faunas to the west difficult and uncertain.

Vanuxem in 1840 recognized[†] a formation in the 3d District which he considered distinct from the Chemung and more recent. He called this the "Montrose sandstone" from the town of Montrose in Pennsylvania where it is well developed.

Mather included all of the rocks of the Catskill mountains in his "Catskill Mountain Series" which he subdivided as follows[‡]:—

1. Conglomerates and grits.
2. Red and gray grits with red shales mottled with green spots.
   Montrose sandstone of Prof. Vanuxem.
3. Chemung group of Prof. Vanuxem.
4. Ithaca group of Prof. Vanuxem.
5. Sherburne flags.
6. ———
7. Hamilton group.
8. Marcellus shales.

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[*] Geol. of N. Y., Part 4, p. 229, 1843.

[†] 4th Ann'l Rep't 3d Geol. Dist., p. 381, 1840.

[‡] 5th Ann'l Rep't 1st Geol. Dist., p. 77, 1841.

In his final Report[*] Vanuxem used the term "Catskill group" for the uppermost member of the New York System which he had previously called Montrose sandstone. The Catskill group continued to be regarded for several years as distinct from and subsequent in time of deposition to the Chemung.

The preliminary work of the classification of the New York strata according to their organic contents into the groups which have since been recognized as the paleontolgic units for the United States was completed with the publication of the final reports of the different districts from 1840 to 1843.

In 1847 Edward de Verneuil visited America and correlated the divisions of the New York System with the European formations.[†] The divisions of the Erie and the five superior divisions of the Helderberg he correlated with the Devonian of England. He proposed to combine the Marcellus shale, Hamilton group and Tully limestone into one division, and the Portage and Chemung groups into a second division of the Devonian.

The discovery in the year 1862 of fish bones of a characteristic Catskill species associated with Chemung fossils in the Catskill rocks created doubt as to the superior position of those deposits. Col. E. Jewett declared his belief that there[‡] "is no Old Red sandstone in the State." Prof. Hall was led by the same fact to modify his views of the extent of the Catskill group. He expressed the opinion that the "greater part of the area colored on the geological map of New York as Catskill group is in fact occupied by the Portage and Chemung."[§]

A comparative study of the Upper Devonian faunas of New York led Prof. H. S. Williams to consider the Chemung and Catskill as contemporaneous formations.[||]

In his vice-presidential address[¶] in 1891 Prof. J. J. Stevenson reviewed in detail the evidence bearing on the relation of the Catskill to the Chemung and their extent. He considered the Catskill and Chemung to have been deposited synchronously in a shallow basin subsiding most rapidly to the east.

Mr. N. H. Darton proposed[**] as the result of stratigraphical studies in the Catskill region that "Catskill" be broadened from the name of an epoch to that of a period, and that it include the Chemung and Portage epochs. This suggestion to substitute the name of a local formation not well characterized paleontologically for one of wide extent with a very distinctive fauna like the Chemung has not met with favor and has been followed by no other writers.

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[*] Geol. of N. Y., Part 3, p. 16, 1842.
[†] Bull. Geol. Soc. of France, 2d ser., vol. iv.
[‡] Am. Jr. Sci., 2d ser., vol. xxxiv, p. 418.
[§] Can. Nat. and Jr. of Sci., new ser., vol. vii, p. 377.
[||] Bull. U. S. Geol. Surv., No. 41.
[¶] Proc. Am. Assoc. Adv. Sci., 1891, p. 241.
[**] Am. Jr. Sci., 3d Ser., vol. xlv, pp. 203–209.

All recent studies of the Catskill group go to show that it is the stratigraphic equivalent of the Upper Devonian of the central and western parts of the State.

In the detailed and careful study of the relations of the Upper Devonian faunas of New York, Prof. H. S. Williams was the leader; and to him more than to any other student, paleontologists are indebted for our present knowledge of these faunas. In the year 1894 he published the results of the study of a section from Cayuga lake to Bradford county, Pennsylvania. The horizons included in this study are shown in the following section*:—

			Feet.
XII.	Barclay coal bed.		1000
XI.	Pottsville conglomerate.		
X.	Mauch Chunk Red shale.		
IX.	Pocono Gray sandstone.		
	Catskill Red sandstone.		
	Upper Chemung fauna in Penna. (top at Ulster)		300
	Typical Chemung fauna (outcropping in the vicinity of State-line, bottom of Chemung Narrows, N.Y.		300
	Lower Chemung fauna (bottom outcrops at Caroline, Danby and Newfield)		600
	Upper Portage Sandstones and Shales of H. S. Williams		600
	Middle Portage.	Upper Ithaca	200
		Typical Ithaca	100
		Lower Ithaca	150
	Lower Portage Sandstones and Shales		250
	Genesee Shales		——
			3500

In this study Dr. Williams attempted to discover the association of the species in faunas and the relation of these to each other. In the Portage rocks at Ithaca two distinct faunas were recognized,—the *Cladochonus* and *Spirifer lævis*,—and the relation of these to those of the Ithaca group was pointed out.†

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* Trans. Am. Inst. Min. Engineers, vol. xvi, p. 945.

† Bull. U. S. Geol. Surv., No. 3, p. 11.

In the Ithaca group Williams recognized five faunas—the *Lingula complanata*, *Spirifer fimbriatus*, *Spirifer mesastrialis*, *Rhynchonella eximia* and *Spirifer mesacostalis*.

The *Lingula complanata* fauna is a recurrence with a slight modification of the fauna found in the Marcellus shales and the Genesee slate. The presence of this fauna and the recurrent Hamilton species in the Ithaca fauna he considered to be the result of a shifting of faunas,—new conditions and faunas driving the Hamilton and Marcellus faunas out of the area in question and permitting them to return at intervals, while in some areas they lived on continuously undisturbed by new conditions.

Above the Ithaca fauna Williams found a recurrent Portage fauna containing *Lunulicardium fragile* and *Glyptocardia speciosa*. The occurrence of these characteristic Portage species above the Ithaca fauna led him to refer it to the Portage group instead of the Chemung where Hall placed it.

In western New York the studies of Williams and Clarke have thrown much light on the relations of the Upper Devonian faunas.

In 1883 Prof. Williams published a paper* on a peculiar fauna in Ontario county at the base of the Chemung in what he called the Naples beds. In this fauna he found a majority of forms to be species characteristic of the Lime Creek beds of Iowa, together with a few species peculiar to the Ithaca and Lime Creek faunas. He therefore correlated the fauna of the Naples beds with the Kinderhook in the West and the Ithaca fauna to the east.

In Ontario county, Prof. Clarke, as a result of his studies (published in 1885†) found that the Portage group, as originally defined by Hall, includes an assemblage of unlike faunas, the lower ones being closely related to the Genesee or Hamilton, while the upper are related to the Chemung. The Cashaqua and Gardeau beds of Hall he includes under the name of the Naples shales. Of the 47 species occurring in the Naples shales, Clarke finds that 34 per cent. occur in the Genesee shale and 19 per cent. in the Hamilton proper, while but 2.1 per cent. occur in the Portage. He concludes, therefore, that the Naples beds should be regarded as constituting the uppermost member of the Hamilton, or together with the Genesee, as representing a distinct geological epoch.

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* Am. Jr. Sci., vol. xxv, p. 97.

† Bull. U. S. Geol. Surv., No. 16.

About 600 feet of sandstone above the Naples beds are referred to the Portage. Only ten species have been found in the fauna of these Portage sandstones, seven of which are common to the Chemung.

It should be observed that "Naples beds" as used by Williams and Clarke represent entirely different horizons. Prof. Williams, who introduced the term, applied it to a horizon "about twelve hundred feet above the highest Genesee slate."* Prof. Clarke has applied the same term to a portion of Hall's Portage lying directly above the Genesee; above the Naples beds of Clarke is the Portage sandstone followed by the High-point bed, which latter is equivalent to the Naples horizon of Williams. In order to avoid confusion, the term Naples beds, if used, should at least include the horizon originally designated by Williams.

As regards the absence of the Ithaca fauna from the Upper Devonian of western New York, the results of Prof. Williams' studies of the Genesee section† correspond with those of Clarke and Williams in Ontario county. The fauna of the Portage group of the Genesee section as given by Prof. Williams is very meagre as compared with the Portage as developed at Ithaca, while it contains some of the more characteristic fossils found at Ithaca, as *Glyptocardia speciosa* and *Lunulicardium fragile*. Most of the species which at Ithaca are common to the Portage and Ithaca groups are absent from the Portage of the Genesse section. Immediately following the Portage, Williams finds the typical Chemung fauna. The peculiarities of the Chemung fauna immediatety above the Portage fauna indicate that it represents a later stage than the Ithaca fauna. At Hornellsville, about half way between the Genesee and Cayuga sections, *Orthis tioga* of the Chemung, and the Chemung stage of *Spirifer mesacostalis* were found directly above shales carrying the Portage *Glyptocardia* fauna. The occurrence in the western sections, immediately above the Portage, of fossils of a type which in the eastern sections were developed after the Ithaca stage, indicates that in the west the Portage fauna must have continued until after the close of the Ithaca stage in the east.

Previous to his study of the Genesee section, Prof. Williams made a comparative study of ten sections through the Upper Devonian. These extended in an east and west direction from the Cuyahoga section near Cleveland, Ohio, to the Chenango section of the Chenango valley. The conclusions which Prof. Williams reached from the study of these sections regarding the character of the Portage, he expresses as follows*: "The Portage rocks and their faunas are comparatively local, belonging to the central part of the area, the fauna failing in the more western sections, and both fauna and lithologic characters are unrecognizable east of the Cayuga section."

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* Am. Jr. Sci., vol. xxv, p. 97, 1883.

† Bull. U. S. Geol. Surv., No. 41.

Concerning the differences between the faunas of the Portage horizon and the Genesee along the Cayuga and eastern sections he says,† "It is evident from the study of the sections, that the interval occupied in the Genesee section by the typical Portage fauna is represented in the Cayuga section by an entirely different set of species, while still farther east in the Chenango and Unadilla sections the same interval is filled by a preliminary stage of the Catskill."

The views which Williams held of the relation of the fauna of the Ithaca group to its antecedent and subsequent faunas, he states as follows: "The Ithaca group of the State reports contains faunas which I have defined as stages in the successive modification of the Hamilton fauna. This set of faunas differs from the Chemung in the absence of several of its common and abundant species and by presenting unmistakable evidences of earlier stages in modification of species which are near enough alike to be classified under the same specific name."‡

The Ithaca fauna, like the Portage, Williams considers to have a limited geographical extent, being best developed in the east, and blending toward the west with the Portage fauna which in the western sections entirely replaces it. The transition at Hornellsville from the *Glyptocardia* fauna of the Portage directly to the lowest true Chemung fauna characterized by *Orthis tioga* he considers evidence that the Ithaca group has no representative in the region west of there. §

The correlation of the Upper Devonian faunas of central and eastern New York with those of the more western has been attended with considerable difficulty owing to the changes in the several faunas in passing westward. In most of this region the Tully limestone and Genesee shale are absent, their most eastern outcrops being on the west side of the Chenango valley. The absence of these formations leaves no definite line of division between the Hamilton and the faunas above. This has led to much uncertainty as to whether the bluish shales and sandstones underlying the Oneonta sandstone and containing a fauna composed of Hamilton fossils and a few Ithaca group species belong in the Hamilton or above the horizon of the Genesee shale. These faunas of uncertain affinities have been studied in Otsego and Chemung counties by Williams, Prosser and Clarke. While these careful observers agree in the main in their conclusions as to the relations of the faunas of this region there are some differences, and it may be worth while to summarize briefly the results of their published studies.

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* Proc. Am. Assoc. Adv. Sci., vol. xxxiv, p. 233.

† *Ibid.*

‡ *Ibid.*

§ Bull. U. S. Geol. Surv., No. 41, p. 30.

In his paper on the classification of the Upper Devonian,* Prof. Williams describes the faunas of the Chenango and the Unadilla river sections. The faunas above the Genesee shale in these sections represent, according to him, five stages of the modified Hamilton fauna and one stage of the Chemung. The stages which he recognizes are the *Paracyclas lirata*, *Atrypa reticularis*, *Leiorhynchus globuliformis*, *Tropidoleptus carinatus*, *Spirifer mesastrialis* stages of the Hamilton followed by the *Rhynchonella contracta* stage of the Chemung. The nearly barren sandstones and conglomerates lying above the last of these stages and intervening between the first two are stages of the Catskill. These modified stages of the Hamilton correspond to the Ithaca group of the Cayuga section. Williams finds no representative of the Portage fauna in these sections.

Prof. Prosser has studied the same sections and has published a complete list of the fossils identified by him in the Unadilla section.†

In another paper ‡ he discusses the correlation of the Upper Devonian faunas of central and eastern New York. In this Prosser recognizes above the typical Hamilton faunas representing two stages of the western sections, the Portage and the Ithaca group stages. The determination of the Portage stage seems to be based on stratigraphic evidence. The presence of the Portage in the Chenango valley is not shown by the lists of fossils given since none of them are characteristic of the typical western Portage. The lists of fossils indicate that the typical

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* Proc. Am. Assoc. Adv. Sci., vol. xxxiv, p. 222.

† 12th Ann'l Rep't State Geol. of N. Y., pp. 1–35.

‡ Am. Jr. Sci., vol. xlvi, pp. 212–230.

Hamilton in the Chenango valley is followed by beds bearing an Ithaca fauna, though these may be the stratigraphic equivalents of the Portage of the western sections.

More recently Prof. J. M. Clarke has studied the fossiliferous beds below the Oneonta sandstone in the Chenango valley. In the western part of Chenango county Prof. Clarke found the *Spirifer mesastrialis* fauna lying unquestionably above the Genesee shales. Where the Genesee and Tully formations in the Chenango valley and the eastern part of the region are absent Clarke makes the presence of *Spirifer mesastrialis* the index of the appearance of the supra-Hamilton fauna. The Portage fauna, according to Clarke, is entirely absent from the Chenango valley. There is, he states,* not a single species common to the typical Portage of the Genesee section and the Ithaca fauna of the Chenango valley.

The Cayuga section, he thinks, represents the mingling of those two faunas, the Portage from the west and the Ithaca fauna from the east.

The immediate successor of the typical Hamilton fauna in this region represents a more perfect and normal development of the Ithaca group fauna, Prof. Clarke thinks,† than is to be found in any of the sections to the west. Overlying the Ithaca group of this region are Oneonta flags and shales. These Oneonta beds Clarke considers to be the equivalent of the typical western Portage. The principal evidence given for this correlation is the occurrence of peculiar concretions found in both formations.

The first diagrammatic presentation of the relations of the Upper Devonian faunas, based on the view that some of them were local faunas imperfectly developed or entirely absent from some of the sections, was a series of sections of the Upper Devonian published by Prof. Williams in 1886.‡

All of the paleontologists who have since studied the New York Devonian have reached similar views as to the local development of the faunas.

Fig. 1, republished from Prof. Clarke's Report § on the Chenango valley, represents probably as accurately as our present knowledge will permit the relations of the Upper Devonian faunas in the eastern, central and western parts of the State.

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* 13th Ann'l Rep't State Geol. of N. Y., p. 555.

† *Ibid.*

‡ Proc. Am. Assoc. Adv. Sci., vol. xxxiv.

§ 13th Ann'l Rep't State Geol. of N. Y., p. 556.

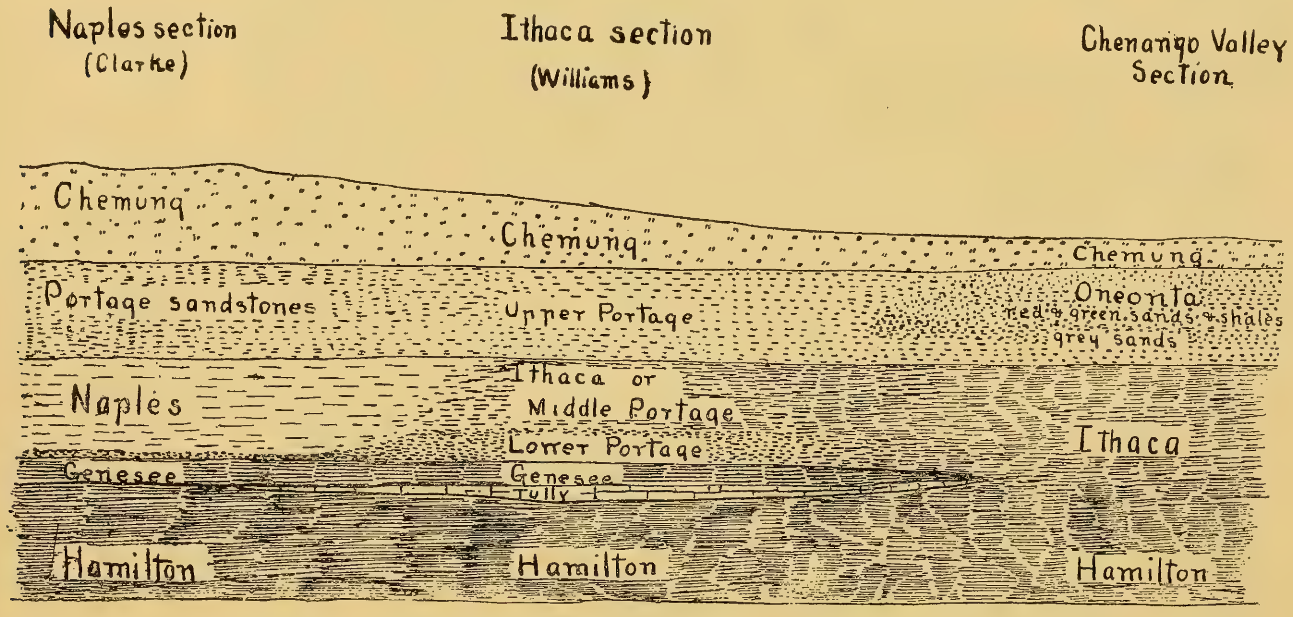
Naples section
(Clarke)
Ithaca section
(Williams)
Chenango Valley
Section
Chemung
Chemung
Chemung
Portage sandstones
Upper Portage
Oneonta
red & green sands & shales
grey sands
Naples
Ithaca or
Middle Portage
Lower Portage
Ithaca
Genesee
Genesee
Tully
Hamilton
Hamilton
Hamilton

FIG. 1.—From an electrotype copy of the original plate used in printing p. 556 of the 13th Ann'l Rep't State Geol. of N. Y.

PART II.

THE ITHACA SECTIONS.

Stratigraphy.—The rocks of the Portage and the Ithaca groups outcrop along the sides of Cayuga lake valley about Ithaca, New York. The Portage rocks rest upon the black Genesee shale, and are terminated above by the Ithaca shale. Tough sandstone flags, often wave-marked, together with beds of more arenaceous character, constitute the Portage rocks, which are here about 250 feet in thickness. The base of the Portage is sharply defined by a fine-grained, hard, blue sandstone about 3 feet in thickness. From Esty's glen to the point where the base of the Portage passes below the surface of the lake, the dip is more than 100 feet to the mile. Near Ithaca the dip becomes less, and to the south it is very slight for several miles.

The soft argillaceous beds which lie above the Portage have been called the Ithaca shale by Prof. Williams. These shales are often stained a reddish brown by iron. Lenticular layers of sandstone sometimes occur in these shales. Above the base of the Ithaca shale 25 or 30 feet, it loses its arenaceous character and is replaced by the sandstone flags and intercalated shales which contain the typical Ithaca fauna. These beds are fossiliferous for a thickness of nearly 400 feet. The rocks containing the Ithaca fauna are followed by nearly 600 feet of barren sandstone flags which extend to the tops of the hills about Ithaca. The fossiliferous beds of the Chemung do not appear in the immediate vicinity of Ithaca, but several miles to the south they form the tops of the hills along the southern extension of Cayuga valley above the barren strata.

The numerous deep gorges of the streams entering the Cayuga valley afford excellent exposures of the rocks about Ithaca, from the base of the Portage to the top of the Ithaca group. Ten sections through these rocks have been carefully studied and the results are given in the following pages.*

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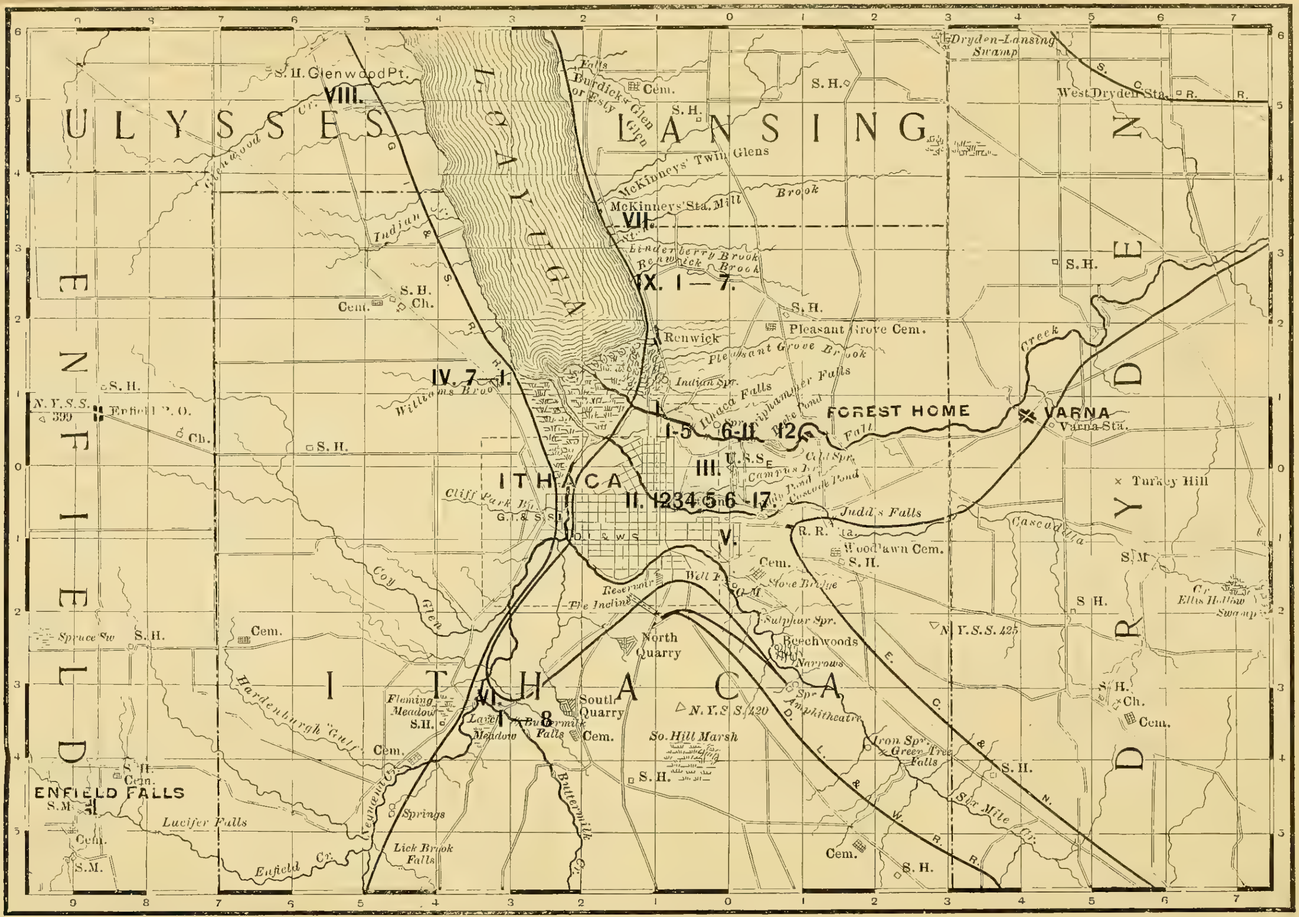
*NOTE.—The sections are numbered in the order in which they were studied. All of the specimens on which the lists of species are based are in the Paleontological Museum. Two numbers are attached to each specimen, the first indicating the section, and the second the stratigraphic position or station in the section from which it came, *e. g.*, 1–2 refers to the second station in the Fall Creek section.


ULYSSES
LANSING
ENFIELD
ITHACA
DRYDEN
CAYUGA L.
ITHACA
FOREST HOME
VARNA
Varna Sta.
ENFIELD FALLS
S. H. Glenwood Pt.
VIII.
Glenwood Cr.
Falls
Burdick's Glen or Esty Glen
Cem.
S. H.
McKinneys' Twin Glens
Brook
McKinneys' Sta. Mill
VII.
Linderberry Brook
Renwick Brook
IX. 1—7.
Indian Cr.
S. H.
Ch.
Renwick
Pleasant Grove Cem.
Pleasant Grove Brook
Indian Spr.
Ithaca Falls
Triphammer Falls
Beebe Pond
Fall Cr.
IV. 7—1.
Williams Brook
I. 1–5 6–11 12
III.
U. S. S.
Cold Spr.
Campus Brook
Lily Pond
Cascade Pond
II. 1234 5 6 -17.
Judd's Falls
Cliff Park Br.
G. I. & S.
D. L. & W. S.
V.
R. R. Sta.
Woodlawn Cem.
Turkey Hill
Cascadilla
N. Y. S. S. 399
Enfield P. O.
Ch.
Coy Glen
Reservoir
The Incline
Well F.
G. M.
Stone Bridge
Sulphur Spr.
N. Y. S. S. 425
Ellis Hollow Swamp
Spruce Sw
Cem.
North Quarry
Beechwoods
Narrows
Hardenburgh Gulf
Fleming Meadow
S. H.
VI.
Lake Meadow
Buttermilk Falls
8
South Quarry
N. Y. S. S. 420
So. Hill Marsh
Spr.
Amphitheatre
Iron Spr.
Green Tree Falls
Six Mile Cr.
Buttermilk Cr.
Neguena Cr.
Springs
Lick Brook Falls
Lucifer Falls
Enfield Cr.
S. M.
Dryden-Lansing Swamp
West Dryden Sta.
S. C. R. R.
E. C. & N.
D. L. & W. R. R.
G. I. & S. R. R.
Creek
Ch.
Cem.
S. H.

Matthews, Northrup & Co., Art-Printing Works, Buffalo, N. Y.

X. 7 — I.

Map.—Ithaca and vicinity, showing location of sections and stations. (From Prof. Gage's plate).

Section I, Fall Creek.

This section begins in the upper Portage sandstone at the foot of Ithaca falls and ends at the outcrops in the bed of the stream above Forest Home. This section includes about 410 feet of strata.

Station 1.—The fauna of this station occurs in the Portage flagstone and shale exposed at the foot of Ithaca falls. This is the best locality known for collecting *Spirifer lævis*, which is the predominant species, and its associated fauna.

The following is a list of species obtained from about three feet of strata: *Spirifer lævis* a*, *Spathella typica* c, *Goniatites sinuosus?* r, *Crania* sp. r, *Cyrtina hamiltonensis* r, *Lunulicardium fragile* a, *Palæoneilo filosa* a, *Orthoceras pecator* r, *Aviculopecten lautus* var. *ithacensis* r, *Goniatites discoideus* c, *Modiomorpha subalata*, *Grammysia subarcuata* r, *Taxocrinus ithacensis* stems, *Chonetes lepida* a, *Pleurotomaria capillaria* r, *Chonetes scitula* r, *Gomphoceras tumidum* r, *Glyptocardia speciosa* r, *Coleolus tenuicinctus*, *Nucula diffidens* r, *Mytilarca chemungensis?* r, *Leiorhynchus mesacostalis*, *Lingula ligea?* r, *Plumulina plumaria* c, *Aviculopecten rugæstriatus?*, *Leda diversa*.

Station 2.—135 feet above *Station 1.*

The rocks containing the fauna of the Ithaca shale are exposed in the vertical cliffs of the falls, so that no representative of it were obtained from this section.

At the summit of Ithaca falls the sandstone and silicious shale contain the following species, indicating the initiation of the Ithaca fauna: *Productella speciosa* c, *Spirifer mesacostalis*, *Chonetes setigera* c, *Ambocœlia umbonata* c, *Pleurotomaria capillaria*, *Microdon tenuistriatus*, *Stictopora meeki* c, *Palæoneilo constricta*, *Actinopteria boydi*, *Orthoceras bebryx* var. *cayuga*, *Modiomorpha subalata* var. *chemungensis* c, *Nucula corbuliformis*.

Station 3.—From the foot of the cascade below the electric light plant, the following species were collected: *Ambocœlia umbonata* a, *Chonetes scitula*, *Rhynchonella eximia* a, *Palæoneilo filosa*, *Leiorhynchus mesacostalis*, *Gomphoceras tumidum* r, *Modiomorpha subalata* var. *chemungensis*, *Actinopteria boydi?* r, *Spirifer mesastrialis* a, *Microdon bellistriatus* r, *Stictopora meeki*, *Pleurotomaria capillaria* r, *Grammysia subarcuata?*, *Cyrtina hamiltonensis* c, *Pro-*

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* The letter placed after a species refers to its abundance,—a, indicating abundant, c, common and r, rare.

ductella speciosa, *Conularia congregata* a, *Monticulopora* sp. r, *Coleolus tenuicinctus* r.

Station 4.—From the top of the cascade at the electric light plant, the following species were obtained: *Spirifer mesastrialis* c, *Leiorhynchus mesacostalis* r, *Microdon bellistriatus*, *Pleurotomaria capillaria* r, *Actinopteria perstrialis?*, *Plumaria plumulina* r, *Stictopora meeki* c, *Orthoceras bebryx* var. *cayuga*.

Station 5 (a).—The following species were obtained a short distance above *Station 4: Cyrtina hamiltonensis?*, *Ambocœlia umbonata*, *Spirifer mesacostalis* r, *Leiorhynchus mesacostalis* c, *Rhynchonella eximia* c, *Rhynchonella stephani* c, *Grammysia subarcuata*, *Stictopora meeki*, *Actinopteria perstrialis*, *Palæoneilo filosa*, *Modiomorpha subalata* var. *chemungensis* c, *Plumaria plumulina*.

Station 5 (b).—About four feet higher than *5*a, just below the foot bridge, in a calcareous layer, the following species occur: *Productella speciosa* a, *Orthis impressa* c, *Atrypa reticularis* c, *Rhynchonella pugnus* c, *Stictopora meeki*.

It will be observed that this is the first occurrence in this section of the last three brachiopoda noted above.

Station 6.—The following species occur in the first exposures above the foot bridge: *Orthis impressa*, *Palæoneilo filosa*, *Strophodonta mucronata* c, *Productella speciosa*, *Actinopteria boydi?* r, *Grammysia subarcuata*, *Tantaculites bellulus*, *Chonetes lepida*, *Chonetes scitula*, *Spirifer mesacostalis* a, *Goniatites sinuosus?*, *Atrypa reticularis*.

Station 7.—In the bottom of the gorge, a short distance above *Station 6*, the following species occur: *Strophodonta mucronata* a, *Productella speciosa*, *Crania* sp., *Pterinea chemungensis?*, *Spirifer mesacostalis* a, *Atrypa reticularis*, *Palæoneilo filosa* r, *Platyceras dumosum?* r, *Orthis impressa* c, *Aviculopecten cancellatus?* r, *Cyrtina hamiltonensis* r, *Goniatites complanatus* r, *Pterinopecten erectus* r, *Modiomorpha subalata* var. *chemungensis* r, *Panenka* sp?.

Station 8.—Just below Triphammer falls, the following species were noted: *Strophodonta mucronata* a, *Goniatites complanatus?*, *Chonetes scitula* r, *Productella speciosa* c, *Orthis impressa* r, *Platyceras erectum* r, *Spirifer mesastrialis* r.

Station 9.—From the lower shelf of Triphammer falls, the following species were obtained: *Chonetes scitula*, *Strophodonta perplana* var. *nervosa*, *Crania* sp., *Productella speciosa* a, *Stropho-*

donta mucronata a, *Spirifer mesacostalis* a, *Atrypa reticularis* a, *Goniatites complanatus?* r, *Edmondia subovata* r, *Nucula corbuliformis* r, *Ambocœlia umbonata* r, *Microdon bellistriatus* c, *Grammysia subarcuata* r, *Palæoneilo filosa* c, *Orthoceras bebryx* var. *cayuga*, *Aviculopecten*, *Cyrtina hamiltonensis*, *Actinopteria boydi* r.

Stations 10 & 11.—The lists of fossils from two slightly different horizons at the top of Triphammer falls having the same fauna have been combined in the following list: *Schizodus chemungensis*, *Edmondia subovata*, *Nucula diffidens*, *Lunulicardium fragile* r, *Cyrtina hamiltonensis* a, *Actinopteria boydi* c, *Productella speciosa* c, *Atrypa reticularis* a, *Modiomorpha subalata* var. *chemungensis* c, *Spirifer mesacostalis* c, *Chonetes setigera* c, *Microdon bellistriatus* r, *Aviculopecten* sp., *Pterinopecten erectus* r, *Crania* sp. r, *Palæoneilo plana* c, *Orthoceras* sp. r, *Platyceras* sp. r, *Mytilarca chemungensis* r, *Palæoneilo filosa* c, *Spathella typica* r, *Goniophora minor* r, *Strophodonta mucronata* a, *Macrodon* sp. r, *Orthis impressa* c, *Pleurotomaria capillaria* r, *Chonetes scitula* c, *Orthoceras bebryx* var. *cayuga?* r, *Aulopora* sp. r, *Chonetes lepida* r, *Orthoceras demus?* r, *Productella hallana* r.

Station 12.—The following species were obtained at the old quarry above Triphammer falls: *Strophodonta mucronata* a, *Palæoneilo constricta*, *Cyrtina hamiltonensis*, *Spathella typica* *Schizodus chemungensis*, *Chonetes scitula*, *Spirifer mesacostalis*, *Productella speciosa*; *Actinopteria boydi*, *Pterinea* (*Vertumnia*) *reproba*.

Station 13.—Below lower bridge, Forest Home.

The shales here contain an abundance of fossils, of which the following species were identified: *Strophodonta mucronata*, *Orthonota parvula*, *Modiomorpha subalata* var. *chemungensis*, *Grammysia subarcuata*, *Palæoneilo maxima*, *P. plana*, *P. constricta*, *Crania* sp?, *Chonetes scitula*, *Orthoceras* sp., *Rhynchonella pugnus*, *Schizodus chemungensis*, *Leda diversa*, *Spirifer mesacostalis*, *Spathella typica*, *Atrypa reticularis*, *Actinopteria boydi*, *Bellerophon ithacensis*, *Aviculopecten cancellatus*, *Pleurotomaria* sp., *Pterinopecten* (*Vertumnia*) *reproba*, *Arthroacantha ithacensis*.

Prof. H. S. Williams informed the writer that he discovered *Spirifer lævis* and its associated fauna near this station but they have not been re-discovered.

Section II, Cascadilla Creek.

The Cascadilla creek section embraces the rocks exposed along the gorge from the old mill to Eddy's dam,—about 320 feet of strata.

Station 1.—This station is in the dark Ithaca shale at the base of the lowest cascade in the gorge. The species common here are typical of the Ithaca shale. They are *Lunulicardium fragile*, *Lingula complanata*, *Leiorhynchus mesacostalis* (sm. var.), *Rhynchonella eximia.*

Station 2.—About 30 feet above *Station 1*, the following species occur: *Glyptocardia speciosa*, *Productella truncata*, *Palæoneilo filosa*, *Leiorhynchus mesacostalis*, *Microdon bellistriatus*, *Orthoceras* sp., *Palæoneilo plana*, *Pleurotomaria capillaria*, *Microdon gregarius.*

Stations 3 & *4.*—About 55 feet above *Station 1*, the following species were found: *Palæoneilo filosa*, *Nucula diffidens*, *N. corbuliformis*, *Microdon gregarius*, *Chonetes scitula*, *Palæoneilo maxima*, *Rhynchonella eximia*, *Modiomorpha subalata* var. *chemungensis*, *Spirifer mesacostalis*, *Leiorhynchus mesacostalis*, *Pleurotomaria capillaria?*, *Productella speciosa*, *Orthoceras* sp., *Actinopteria boydi.*

Station 5.—95 feet above *Station 1*, the following species were obtained: *Spirifer mesacostalis*, *Rhynchonella eximia*, *Nucula diffidens*, *Palæoneilo constricta*, *P. filosa*, *P. plana*, *P. maxima*, *Actinopteria perstrialis*, *Modiomorpha subalata* var. *chemungensis*, *Microdon gregarius*, *Chonetes setigera*, *C. scitula.*

Station 6.—122 feet above *Station 1*, the following species occur: *Microdon bellistriatus*, *Actinopteria boydi*, *Rhynchonella stephani*, *Spirifer mesastrialis*, *Grammysia subarcuata*, *Nucula corbuliformis*, *Pleurotomaria capillaria*, *Modiomorpha subalata* var. *chemungensis*, *Ambocœlia umbonata*, *Spirifer mesacostalis*, *Leiorhynchus mesacostalis*, *Orthoceras* sp., *Chonetes scitula*, *Palæoneilo maxima*, *P. constricta*, *P. filosa*, *Cyrtina hamiltonensis*, *Cryptonella eudora.*

Station 7.—The following species were obtained 150 feet above *Station 1: Spirifer mesacostalis*, *Pterinea reproba*, *Pleurotomaria capillaria*, *Leptodesma sociale*, *Chonetes scitula*, *Actinopteria perstrialis?*, *Stictopora meeki*, *Goniatites* sp., *Grammysia elliptica*, *Chonetes setigera*, *Actinopteria* sp?, *Cyrtina hamiltonensis*, *Bellerophon* sp., *Modiomorpha subalata* var. *chemungensis*, *Actinopteria boydi*, *Palæoneilo plana*, *Rhynchonella eximia*, *Plumulina plumaria*, *Gomphoceras tumidum*, *Cryptonella eudora*.

Station 8.—The following fauna was noted 180 feet above *Station 1: Pleurotomaria capillaria?*, *Palæoneilo plana*, *Productella speciosa*, *Spirifer mesacostalis*, *Cryptonella eudora*, *Actinopteria boydi*, *Stictopora meeki*, *Rhynchonella eximia*, *Modiomorpha subalata* var. *chemungensis*, *Cyrtina hamiltonensis*.

Station 9.—I have obtained the following species 195 feet above *Station 1: Cyrtina hamiltonensis*, *Gomphoceras tumidum*, *Actinopteria perstrialis*, *Pleurotomaria capillaria*, *Spathella typica*, *Orthoceras bebryx* var. *cayuga*, *Nucula corbuliformis*, *Schizodus chemungensis*, *Palæoneilo plana*, *P. constricta*, *Elymella nuculoides?*, *Stictopora meeki*, *Spirifer mesastrialis*, *Chonetes scitula*.

Station 10.—At the foot of the falls, just below Heustis Street bridge, 225 feet above *Station 1*, the following species occur: *Atrypa reticularis*, *Productella speciosa*, *Rhynchonella pugnus*, *Orthis impressa*, *Spirifer mesacostalis*, *Cyrtina hamiltonensis*, *Strophodonta mucronata*.

Stations 11 & *12.*—From the arenaceous sandstone and shale under the Heustis Street bridge, the following species were obtained: *Aulopora* sp., *Palæoneilo filosa*, *Mytilarca chemungensis*, *Spirifer mucronatus*, *Actinopteria boydi*, *Orthis impressa*, *Productella speciosa*, *Cyrtina hamiltonensis*, *Strophodonta perplana* var. *nervosa*, *S. mucronata*, *Orthoceras pecator*, *Rhynchonella pugnus*, *Schizodus chemungensis*, *Microdon bellistriatus*, *Palæoneilo constricta*, *Modiomorpha subalata* var. *chemungensis*, *Edmondia subovata?*, *Goniophora minor?*, *Microdon chemungensis*.

Station 13.—The following species were obtained below the electric railroad bridge, 285 feet above *Station* 1*: Atrypa reticularis*, *Loxonema* sp., *Productella speciosa*, *Microdon* sp., *Strophodonta mucronata*, *Chonetes scitula*, *C. lepida*, *Goniophora minor?*, *Modiomorpha subalata* var. *chemungensis*, *Cyrtina hamiltonensis*, *Schizodus chemungensis*, *Goniatites* sp., *Palæoneilo filosa*, *Straphodonta perplana* var. *nervosa*, *Aviculopecten* sp.

Station 14.—The following fauna was found 300 feet above *Station 1: Edmondia subovata*, *Chonetes lepida*, *Ptychodesma nanum?*, *Pleurotomaria capillaria*, *Palæoneilo filosa*, *P. constricta*, *Mytilarca chemungensis*, *Microdon bellistriatus*, *Actinopteria perstrialis?*, *Bellerophon leda*, *Modiomorpha subalata* var. *chemungensis*, *Macrodon* sp., *Strophodonta mucronata*, *S. perplana* var. *nervosa*, *Actinopteria boydi*, *Atrypa reticularis*, *Pterinea* sp?, *Lunulicardium fragile*, *Grammysia subarcuata*, *Nucula corbuliformis?*, *Spirifer mesacostalis*, *Productella speciosa*, *Pterinopecten reproba?*, *Ambocœlia umbonata*, *Macrodon chemungensis*.

Station 15.—305 feet above *Station 1*, the following fauna occurs: *Palæoneilo plana*, *P. filosa*, *P. constricta*, *Macrodon chemungensis*, *Crania* sp., *Atrypa reticularis*, *Actinopteria boydi*, *Spathella typica*, *Schizodus chemungensis*, *Aulopora* sp., *Microdon bellistriatus*, *Pleurotomaria capillaria?*, *Cyrtina hamiltonensis*, *Strophodanta mucronata*, *Spirifer mesacostalis*, *Chonetes scitula*, *Nucula corbuliformis?*

Station 16.—The fauna of this station occurs under the foot bridge below the dam, 320 feet above *Station 1*: *Palæoneilo constricta*, *P. filosa*, *P. plana*, *Microdon bellistriatus*, *Cyrtina hamiltonensis*, *Crania* sp., *Productella speciosa*, *Pleurotomaria capillaria*, *Spirifer mucronatus*, *Modiomorpha subalata* var. *chemungensis*, *Bellerophon leda?*, *Chonetes scitula*, *Atrypa reticularis*, *Spathella typica*, *Strophodonta mucronata*, *Schizodus chemungensis*.

Stations 17 & *18*.—The following species were obtained from the beds exposed at the end of the foot bridge, about 10 feet above the last station: *Schizodus chemungensis*, *Atrypa reticularis*, *Chonetes scitula*, *Crania hamiltoniæ?*, *Strophodonta mucronata*, *Grammysia* sp., *Actinopteria boydi*, *Microdon bellistriatus*, *Chonetes lepida*, *Modiomorpha subalata*, *Palæoneilo filosa*, *Productella speciosa*, *Spathella typica?*, *Tentaculites spiculus*, *Cyrtina hamiltonensis*, *Modiomorpha subalata* var. *chemungensis*, *Crania* sp., *Goniophora minor*, *Palæoneilo constricta*, *Aviculopecten* sp., *Nucula diffidens*, *Stictopora meeki*, *Spirifer mesacostalis*, *Grammysia subarcuata*, *Orthoceras bebryx* var. *cayuga*.

Section III, University, McGraw and Cornell Quarries

This section includes only about 60 feet of Ithaca group strata.

Station 1.—The quarry below the McGraw–Fiske mansion at the edge of Fall Creek gorge, which is 175 feet above the *Spirifer lævis* bed at the foot of the falls, furnished the following fauna: *Cyrtina hamiltonensis* r, *Leiorhynchus mesacostalis* c, *Spirifer mesacostalis* c, *Grammysia subarcuata?* r, *Microdon bellistriatus* c, *Goniophora* sp., *Modiomorpha subalata* var. *chemungensis* c, *Rhynchonella eximia*; *Palæoneilo filosa*, *Chonetes scitula* a, *C. setigera* c, *Orthoceras bebryx* var. *cayuga* r, *Pleurotomaria capillaria* r, *Lingula complanata* r, *Palæoneilo plana.*

Station 2.—The quarry in the cemetery lies about 25 feet above the last. *Plumulina plumaria* occurs here rather abundantly. Some of the species associated with it are *Pleurotomaria capillaria*, *Rhynchonella eximia*, *Spirifer mesacostalis*, *S. mesastrialis*, *Actinopteria* sp.

Station 3.—University quarry is about 235 feet above the *Spirifer lævis* zone in Fall creek. The *Spirifer mesastrialis* fauna reaches its best development here. The species identified from this quarry are as follows: *Spirifer mesastrialis* a, *S. mesacostalis* c, *Rhynchonella eximia* c, *Cryptonella eudora* a, *Bellerophon* sp?, *Spathella typica?*, *Platystoma lineatum* var. *callosum* r, *Pleurotomaria capillaria* r, *Cyrtina hamiltonensis* c, *Pterinopecten erectus* r, *Stictopora meeki* c, *Gomphoceras tumidum* r, *Actinopteria boydi*, *Orthoceras bebryx* var. *cayuga*, *Leptodesma sociale?*.

Section IV, Williams Creek.

This section affords a good continuous exposure of the rocks from the upper *Spirifer lævis* zone of the Portage well up into the Ithaca group.

Station 1.—At the southwest corner of the lake, about 6 feet above its level, the upper Portage *Spirifer lævis* fauna occurs. The following species were found: *Spirifer lævis*, *Aulopora* sp., *Palæoneilo filosa*, *Orthoceras* sp., *Crania* sp., *Cyrtina hamiltonensis.*

Station 2.—At the old quarry near the railroad, about ½ mile south of Williams creek, the following species were obtained about 15 feet above the level of the lake: *Goniatites discoideus*, *Palæoneilo filosa*, *Orthoceras* sp., *Chonetes lepida?*, *Leptodesma* sp., *Palæoneilo constricta*, *Aulopora* sp.

Stations 3 & 4.—These two stations occur in the Ithaca shale about 60 feet above the lake. The following species were found: *Lunulicardium fragile* c, *Productella speciosa* a, *Lingula complanata* a, *Leptodesma sociale*, *Orthoceras pecator.*

Station 5.—This station is 265 feet above the lake in a bed of impure limestone about 5 feet in thickness. Nearly all of the following list of species are from this limestone, but a few are from the shale immediately beneath: *Atrypa reticularis* a, *A. spinosa* c, *Spirifer mesacostalis*, *S. mesastrialis* c, *Cyrtina hamiltonensis* c, *Cryptonella eudora* c, *Leiorhynchus mesacostalis*, *Stictopora*

meeki a, *Palæoneilo filosa* r, *P. constricta* r, *Mytilarca chemungensis* c, *Rhynchonella pugnus* a, *Goniatites sinuosus* r, *Productella speciosa* a, *Spirifer mesacostalis* a, *Goniatites complanatus?* r, *Actinopteria boydi?* r, *Orthoceras* sp. c, *Strophodonta mucronata*, *S. perplana* var. *nervosa*, *S. demissa?* r, *Bellerophon* sp. r, *Goniophora minor* r, *Modiomorpha subalata* var. *chemungensis* c, *Nucula diffidens* c, *N. corbuliformis*, *Glossites depressus* r, *Rhynchonella eximia* c, *R. stephani*, *Schizodus chemungensis* r, *Microdon gregarius*, *Pterinopecten* sp., *Aviculopecten striatus* r, *Pleurotomaria capillaria*, *Platyceras* sp., *Actinopteria boydi*, *Orthis impressa* a, *Grammysia subarcuata* r, *Zaphrentis simplex?* r.

Station 6.—This horizon, which is just above the wagon road and 330 feet above the lake, afforded the following species: *Orthis impressa*, *Atrypa reticularis*, *A. aspera*, *Productella speciosa*, *Spathella typica*, *Strophodonta perplana* var. *nervosa*, *S. mucronata*, *Chonetes setigera*, *Rhynchonella pugnus*, *Goniatites complanatus*, *Spirifer mesacostalis*, *Mytilarca chemungensis*, *Orthoceras* sp.

Station 7.—About 10 feet above the last station, the following species were collected: *Grammysia* sp?, *Porcellia nais*, *Atrypa reticularis*, *Spirifer mucronatus*, *Orthis* sp., *Productella speciosa*, *Chonetes lepida*, *Palæoneilo filosa*, *Platyceras bucculentum*, *Strophodonta mucronata*, *Actinopteria boydi.*

Section V, Quarries.

This section has for its lowest station a rock exposure in the bank of Six Mile creek at the Cayuga Street bridge. All the other stations are in the quarries on South Hill and on the north side of Six Mile creek. The section includes a thickness of 230 feet beginning in the Ithaca shale.

Station 1.—Six Mile creek at Cayuga Street crossing.

Just above the Cayuga Street bridge, about ten feet of dark shale are exposed. The following three species of the Ithaca shale are found here rather abundantly: *Lunulicardium fragile*, *Lingula complanata*, *Glyptocardia speciosa.*

Station 2.—Quarry at Inclined plane, 115 feet above *Station 1.* The following species were obtained here: *Chonetes scitula*, *Spirifer mesacostalis*, *Spathella typica?*, *Leiorhynchus mesacostalis*, *Palæoneilo constricta.*

Station 3.—Quarry at the south end of Hazen Street.

The lower layers of the sondstone contain an abundance of fossils. The most abundant species are *Rhynchonella eximia*, *Leiorhynchus mesacostalis*, *Modiomorpha subalata* var.*chemungensis*.
The following is a list of the less abundant, associated species: *Orthoceras bebryx* var. *cayuga*, *O. leander*, *Stictopora meeki*, *Actinopteria perstrialis*, *Callonema* sp., *Leptodesma* sp., *Discina grandis*, *Goniophora hamiltonensis*, *Nucula diffidens*, *Plumulina plumaria*, *Conularia congregata*, *Schizodus chemungensis*, *Microdon bellistriatus*, *Productella speciosa*, *Ambocœlia umbonata?*, *Spirifer mesastrialis*, *Leptodesma matheri?*, *Grammysia subarcuata*, *G. bisulcata*, *Chonetes scitula*, *Gomphoceras tumidum*, *Leiopteria* sp?, *Tentaculites spiculus*, *Modiomorpha mytiloides*, *Strophodonta perplana*.

Station 4.—Quarry at the south end of Cayuga street.
The sandstone here is inclined to be shelly and thin bedded. Fossils are not very abundant. The following species were collected: *Rhynchonella eximia* c, *Chonetes setigera*, *C. scitula*, *Lingula complanata*, *Microdon bellistriatus*, *Grammysia subarcuata?*, *Modiomorpha subalata* var. *chemungensis* c, *Orthoceras bebryx* var. *cayuga*, *Pleurotomaria capillaria*, *Plumulina plumaria*.
The occurrence of *Lingula complanata*, of which a single specimen was found at this station in the midst of the Ithaca fauna, is worthy of special note. This is the most abundant and characteristic species of the Ithaca shale, but is seldom found in the typical Ithaca fauna.

Station 5.—Quarry southwest of Quarry Street bridge, 140 feet above *Station 1*.
The following species occur here, the first four being very abundant in some layers: *Rhynchonella eximia*, *Spirifer mesacostalis*, *S. mesastrialis*, *Stictopora meeki*, *Glossites depressus?*, *Leiorhynchus mesacostalis*, *Platyceras* sp?, *Orthoceras bebryx* var. *cayuga*, *Cryptonella eudora* r, *Microdon bellistriatus*, *Modiomorpha subalata* var. *chemungensis*, *Pterinopecten erectus*, *Discina grandis*.

Station 6.—Inclined plane above the railroad, 170 feet above *Station 1*.
The species constituting the bulk of the fauna at this locality are *Spirifer mesastrialis*, *S. mesacostalis*, *Stictopora meeki*.
Species less common are *Palæoneilo filosa*, *Cyrtina hamiltonensis*.

Station 7.—Quarry at the south end of Hazen street, 230 feet above *Station 1*.
The following is the list of species obtained at this quarry:

Schizodus chemungensis, *Chonetes lepida*, *C. scitula*, *Leda diversa*, *Orthis impressa*, *Spirifer mesastrialis* a, *Actinopteria boydi?*, *Rhynchonella pugnus* c, *Crania* sp., *Strophodonta perplana* var. *nervosa*, *Goniophora minor*, *Strophodonta mucronata*, *Actinopteria* sp., *Microdon bellistriatus*, *Orthoceras bebryx* var. *cayuga*, *Aulopora* sp., *Ambocœlia umbonata*, *Pterinea reproba*, *Palæoneilo plana*, *Productella speciosa*, *Cyrtina hamiltonensis*, *Atrypa reticularis*, *Porcellia nais?*, *?Mesothyra* sp., *Arthroacantha ithacensis*.

Spirifer mesastrialis and *Productella speciosa* are the predominant species at this station. *Strophodonta perplana* var. *nervosa*, which is not a common species at most localities, is rather common in the upper part of the quarry. *Rhynchonella pugnus* is also quite common in the lower part of the quarry.

Section VI, Buttermilk Creek.

This section includes about 250 feet of strata beginning in the Ithaca shale at the base of Buttermilk falls.

Station 1.—Base of Buttermilk falls.

A very interesting fauna occurs in the dark shale at the foot of the falls. The following species have been recognized: *Lingula punctata* a, *L. spatulata?*, *Leiorhynchus mesacostalis* a, *Orthis vanuxemi* a, *Palæoneilo constricta*, *Coleolus* sp., *Loxonema delphicola* c, *Pleurotomaria capillaria*, *Grammysia subarcuata* c, *Leptodesma sociale*, *Ambocœlia umbonata*, *Actinopteria* sp., *Sticlopora meeki*, *Productella speciosa* (sm. var.), *Rhynchonella eximia?*, *Nucula diffidens* c, *Orthoceras* sp., *Macrocheilus* (*Holopea*) *macrostomus?*, *Phthonia cylindrica*.

The Ithaca shale fauna at this station contains three species which have not before been recognized in the Ithaca group. Two of these are referred with doubt, owing to the slightly flattened condition of the specimens to *Macrocheilus* (*Holopea*) *macrostomus* and *Phthonia cylindrica*, both of which are Hamilton species. The specimens referred to *Orthis vanuxemi* are identical with the Hamilton specimens of this species; they occur abundantly through a few inches of strata.

Station 2.—60 feet above *Station 1.*

The following is a list of the species collected at this point: *Modiomorpha subalata* var. *chemungensis*, *Nucula diffidens*, *Palæoneilo filosa* a, *P. constricta*, *Sticlopora meeki*, *Lunulicardium fragile*, *Macrocheilus* sp., *Pleurotomaria capillaria*, *Schizodus* sp., *Modio-*

morpha quadrula?

Station 3.—97 feet above *Station 1.*

The following species were obtained at this station: *Microdon gregarius*, *Modiomorpha subalata* var. *chemungensis*, *Rynchonella eximia*, *Lingula spatulata*, *Productella speciosa*, *Nucula diffidens?*, *Palæoneilo constricta* a, *Leiorhynchus mesacostalis* a, *Chonetes scitula*, *Palæoneilo plana?*

Station 4.—162 feet above *Station 1.*

The following species were obtained from the dark arenaceous sandstone above the falls: *Spirifer mesacostalis* c, *Cyrtina hamiltonensis*, *Stictopora meeki*, *Modiomorpha subalata?*, *M. subalata* var. *chemungensis*, *Palæoneilo constricta*, *Nucula corbuliformis?*, *Leda diversa*, *Actinopteria perstrialis* a.

This station is the first of this section in which *Spirifer mesacostalis* occurs in abundance and marks the beginning of the typical Ithaca fauna.

Station 5.—At the foot of the dam, 182 feet above *Station 1.*

The sandstone flags here contain an abundant fauna similar to that in the University quarry. The following species were identified: *Spirifer mesastrialis* a, *S. mesacostalis* a, *Cryptonella eudora*, *Cyrtina hamiltonensis*, *Stictopora meeki*, crinoid stems.

Station 6.—35 feet above the last station.

The following characteristic species of the Ithaca group occur here abundantly: *Atrypa reticularis*, *Spirifer mesacostalis*, *Strophodonta mucronata*, *Productella speciosa.*

Station 7.—242 feet above *Station 1.*

The following species occur here in the arenaceous, shelly sandstone: *Strophodonta mucronata*, *Spirifer mesacostalis*, *Atrypa reticularis*, *Microdon bellistriatus.*

Section VII, McKinney's Station.

This section extends from the base of the lower Portage into the Ithaca group. The exposures on which it is based occur along the east side of Cayuga lake from the point where the Genesee disappears beneath the lake to McKinney's station, and in the north glen at the station.

Station 1.—At the sinking of the Genesee beneath the lake.

About 10 feet above the lake, in the Portage shales, two species occur in some layers rather abundantly. These are *Glyp-*

tocardia speciosa and *Chonetes lepida.* A single small specimen of *Spirifer* resembling *S. mesastrialis* was found at this station.

Station 2.—About ½ mile south of *Station 1*, at the side of the railroad, the following species were found: *Lunulicardium fragile*, *Glyptocardia speciosa*, *Goniatites sinuosus*, *Chonetes lepida*, *Coleolus aciculum*, *Strophodonta mucronata*, *Cladochonus* sp., *Lingula spatulata*, *Palæoneilo emarginata.*

The occurrence of *Strophodonta mucronata* here in the lower Portage fauna is of special interest since it is a very abundant fossil in the Ithaca group.

Station 3.—A short distance south of *Station 2*, at the side of the railroad, the following species have been obtained in the Portage shales: *Cladochonus* sp., *Strophodonta mucronata*, *Nuculites oblongus*, *Ambocœlia umbonata*, *Chonetes lepida*, *Pleurotomaria* sp., *Palæoneilo constricta*, *P. filosa*, *Glyptocardia speciosa*, *Coleolus aciculum*, *Lunulicardium fragile*, *Leptodesma sociale?*, *Goniatites discoideus*, *G. sinuosus*, *Loxonema* sp., crinoid stems.

Station 4.—In the north glen at McKinney's station, 20 feet above the lake.

In the tough arenaceous sandstone at this horizon, a second zone of *Spirifer lævis* has been discovered. The associated fauna of *S. lævis* at this horizon appears to be much less abundant than that of the upper zone. The only other species identified are *Strophodonta mucronata*, a species of *Macrodon*, and *Goniatites sinuosus.* The upper *S. lævis* bed in this section lies 110 feet higher.

Station 5.—35 feet above *Station 4* and 85 feet below the upper *Spirifer lævis* bed, the following species were obtained: *Glyptocardia speciosa*, *Rhynchonella pugnus*, *Coleolus aciculum*, *Actinopteria boydi?*, *Goniatites* sp., *Leda diversa*, *Grammysia* sp?, *Mytilarca chemungensis*, *Lunulicardium fragile?*

The discovery of *Rhynchonella pugnus* at this station extends its vertical range in this region from a limited zone in the Ithaca group into the middle Portage, about 100 feet below the base of the Ithaca group.

Station 6.—The shelly sandstone and silicious shale at this station which is 75 feet above the lake and 65 feet below the upper *Spirifer lævis* zone, contain an abundance of *Glyptocardia speciosa* and *Lunulicardium fragile;* associated with these are *Strophodonta mucronata*, *Palæoneilo filosa*, *Nucula diffidens*, *Goni-*

atites sp., *Coleolus* sp.

Station 7.—The upper *Spirifer lævis* zone of the Portage is exposed here, 140 feet above the lake. *Spirifer lævis* occurs here even more abundantly than at the Fall Creek locality. The small number of associated species obtained is due doubtless to the small amount of time spent in collecting them. They are as follows: *Chonetes lepida*, *Nucula* sp., *Crania* sp., *Leda diversa*, *Palæoneilo filosa* a, *Lunulicardium fragile*, crinoid stems.

The *S. lævis* bed is followed by about 20 feet of coarse shales alternating with thin bedded sandstone to the base of the Ithaca shale.

Station 8.—From the lower part of the Ithaca shale, 160 feet above the lake, the following species were obtained: *Lunulicardium fragile* a, *Leptodesma sociale* a, *Lingula complanata* a, *Coleolus aciculum*, *Conularia congregata*.

Station 9.—At the top of the falls, 225 feet above the lake, the dark blue shaly sandstone contains a sparse fauna from which the following species were recognized: *Productella truncata*, *Palæoneilo constricta*, *Pleurotomaria* sp., *Nucula* sp.

Station 10.—285 feet above the lake, the following species were collected: *Modiomorpha neglecta?*, *Palæoneilo constricta*, *P. filosa*, *Glyptocardia speciosa*, *Spirifer mesacostalis*, *Rhynchonella eximia*, *Nucula diffidens*, *Pleurotomaria* sp., *P. capillaria*, *Nuculites triqueter*, *Taxocrinus ithacensis*.

The finding of *Nuculites triqueter* at this station adds one more species to the list of recurrent Hamilton fossils in the Ithaca group.

The presence of *Glyptocardia speciosa* at this station is an interesting instance of the recurrence of one of the most characteristic lower Portage fossils in the Ithaca fauna above the Ithaca shale.

Station 11.—This station which is 300 feet above the lake and 160 feet above the upper *Spirifer lævis* zone is the highest point at which good outcrops can be obtained. The following species were found here: *Palæoneilo constricta*, *Leiorhynchus mesacostalis* a, *Chonetes scitula*, *Spirifer mesacostalis*, *Microdon gregarius*, *Rhynchonella eximia*, *Palæoneilo filosa*.

Section VIII, Glenwood.

The Glenwood section includes 385 feet of strata exposed by the stream entering the lake at Glenwood. The section begins in the Genesee shale and ends in the lower part of the Ithaca group. No collecting was done in the lower part of the section.

Station 1.—Just below the railroad, 170 feet above the lake.

The following characteristic lower Portage species were obtained here: *Glyptocardia speciosa* a, *Palæoneilo constricta*, *Goniatites sinuosus*, *Orthoceras* sp., *Ambocœlia umbonata.*

Station 2.—210 feet above the lake.

The upper *Spirifer lævis* zone was found at this point. The fauna obtained here is as follows: *Spirifer lævis* a, *Orthoceras* sp., *Leda diversa*, *Plumulina plumaria*, *Palæoneilo brevis*, *Lunulicardium fragile*, *Aulopora* sp., *Lingula* sp., *Chonetes lepida*, *Grammysia subarcuata*, *Goniatites* sp., *Schizodus* sp?

Station 3.—260 feet above the lake.

The *Lingula* shale here contain abundant specimens of the following species: *Lingula complanata*, *L. punctata*, *Leiorhynchus mesacostalis*, *Productella speciosa*, *Psilophyton princeps.*

Station 4.—360 feet above the lake.

This station is above the Ithaca shale in the lower part of the Ithaca group. It is remarkable for the great abundance of the species which occur in the sandy shales, and for the presence of *Phacops rana* in abundance in a single layer. The list of fossils obtained is as follows: *Chonetes scitula* a, *C. setigera* a, *C. lepida* c, *Ambocœlia umbonata* c, *Leiorhynchus mesacostalis* a, *Glossites depressus*, *Modiomorpha subalata* var. *chemungensis*, *Grammysia subarcuata*, *Lingula complanata*, *Palæoneilo constricta*, *Poteriocrinus* sp., *Rhynchonella eximia*, *Conularia congregata*, *Strictopora meeki*, *Crania hamiltoniæ* c, *Lepidodendron* sp., *Mesothyra* sp?

Station 5.—385 feet above the lake.

The species noted at this station are *Productella speciosa*, *Ambocœlia umbonata*, *Orthoceras* sp., *Microdon gregarius*, *Modiomorpha subalata* var. *chemungensis.*

Section IX, Renwick Brook.

This section is located about ½ mile north of the southeast corner of the lake. The vertical section studied here is about 250 feet in thickness, beginning below the upper *Spirifer lævis* bed of the Portage.

Station 1.—This station which is 45 feet above the lake, marks the position of the upper *Spirifer lævis* zone of the Portage. Very few fossils besides *S. lævis* were found; they consist principally of fragments of *Goniatites* sp., crinoid stems, *Orthoceras bebryx* var. *cayuga*, and *Glossites depressus?*

Station 2.—In the Ithaca shale, 50 feet above *Station 1*, the following fauna was found: *Lunulicardium fragile* a, *Leptodesma sociale* a, *Leiorhynchus mesacostalis*, *Goniatites discoideus*, *Lingula complanata*.

Station 3.—95 feet above *Station 1*, the following fauna occurs: *Leiorhynchus mesacostalis*, *Lingula complanata*, *Loxonema* sp., *Productella speciosa*, *Chonetes scitula*, *Orthoceras pecator*, *Leptodesma sociale*.

Station 4.—195 feet above *Station 1*, the following species occur: *Pleurotomaria capillaria*, *Spirifer mesacostalis*, *Modiomorpha subalata* var. *chemungensis*, *Grammysia subarcuata*, *Palæoneilo plana*, *Productella speciosa*, *Rhynchonella eximia*, *Leiorhynchus mesacostalis*.

Station 5.—*Plumulina plumaria* occurs at this point, 220 feet above *Station 1*, in a single stratum, in great abundance. Associated with it are *Rhynchonella eximia*, *Crania* sp., *Spirifer mesacostalis*, and *Ambocœlia umbonata*.

Stations 6 & *7.*—235 feet above *Station* 1, the following fauna occurs: *Rhynchonella stephani*, *R. eximia*, *Actinopteria* sp., *Gomphoceras tumidum*, *Euomphalus* sp?, *Ambocœlia umbonata*, *Pleurotomaria* sp., *Chonetes setigera*.

Section X, Newfield Creek.

The exposures of the Newfield section occur along the gorge of Newfield creek. The section begins in the Ithaca group rocks and extends through them to the unfossiliferous flags and shales above. From the last station of this section, which is 350 feet above the Inlet valley, to the tops of the hills which rise 700 feet above the valley, the flags and shales appear to be entirely barren of fossils.

Station 1.—At the foot of the cascade at the lower end of the gorge, the rock is an arenaceous, shelly sandstone. The horizon here is evidently above the Ithaca shale. Only a few fossils were obtained. *Palæoneilo constricta*, *Chonetes scitula* and *Nucula diffidens* being the most abundant.

Station 2.—Above the cascade, 60 feet higher than *Station 1*, the more common species are *Leiorhynchus mesacostalis*, *Modiomorpha subalata* var. *chemungensis*, *Ambocœlia umbonata*, and *Nucula diffidens.*

Station 3.—At this station, 15 feet above the last, the predominant fossils are *Modiomorpha subalata* var. *chemungensis*, *Chonetes setigera* and *C. scitula.*

Station 4.—The predominant fossils at this point which is 160 feet above *Station 1*, are *Spirifer mesacostalis* and *S. mesastrialis.* Some of the associated fossils are *Cyrtina hamiltonensis*, *Rhynchonella eximia*, *Palæoneilo constricta*, and *Actinopteria perstrialis.*

Station 5.—180 feet above *Station 1.*

A calcareous layer about 18 inches thick occurs here containing an abundance of crinoid stems and Monticuliporoid corals.

The following species were obtained here: *Schizodus chemungensis*, *Glossites depressus*, *Strictopora meeki*, *Microdon gregarius*, *Actinopteria boydi*, *Callopora* sp.

Station 6.—195 feet above *Station 1.*

The abundant and characteristic fossils at this horizon are *Atrypa reticularis*, *Productella speciosa*, and *Spirifer mesacostalis.*

Station 7.—350 feet above *Station 1.*

This station is about ½ mile below the village of Newfield at the first rock exposure below the flour mill. A remarkable recurrent Portage fauna occurs at this locality entirely above the Ithaca group fauna. The following species were obtained: *Glyptocardia speciosa*, *Lunulicardium fragile*, *Palæoneilo constricta*, *Coleolus* sp.

Prof. Williams has found, from about the same horizon, the following additional Portage species: *Lingula complanata*, *Bellerophon mæra*, *Strophodonta mucronata.*

Above this station for a distance of more than 300 feet, the rocks consist of shales and thin bedded sandstones, and appear to be barren of fossils.

ca Faunas at Ithaca, N. Y.*

Ithaca Group.

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TABLE SHOWING THE RANGE OF SOME OF THE SPECIES OF THE PORTAGE AND ITHAA FAUNAS AT ITHACA, N. Y.*

	Lower Portage.													Ith. Sh.		Ithaca Group.																	
	240	220	200	180	160	140	120	100	80	60	40	20	†	20	40	60	80	100	120	140	160	180	200	220	240	260	280	300	320	340	360	380	400
Stictopora meeki	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	o	.	.	.	o	o	o	o	o	.	o	.	.	.	o	.	.	.
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Bellerophon ithacensis	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	o
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Schizodus chemungensis	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	o	.	o	o	o	o	.	.	.	o
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Mytilarca chemungensis	.	.	.	.	.	.	.	.	o	.	.	.	o	.	.	.	.	.	.	.	.	.	.	.	.	.	o	o	o	.	.	.	.
Modiomorpha subalata var. *chemungensis*	.	.	.	.	.	.	.	.	.	.	.	.	o	.	.	.	o	.	.	o	o	o	o	o	o	.	o	o	.	o	.	o	o
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Aviculopecten cancellatus	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	o
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Pterinea (Vertumnia) reproba	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	o	.
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* The figures above each column in this table indicate the vertical distance above or below the upper *Spirifer lævis* bed of the Portage. This table is based on four sections in which the *Spirifer lævis* zone has been ascertained.

† *Spirifer lævis* zone.

PART III.

LIST OF SPECIES OCCURRING IN THE POTRAGE AND ITHACA GROUPS.

The present list contains all of the species which have been found by the writer or reported by other from these faunas at Ithaca, together with notes on their range, abundance and variation.

Cœlenterata.

Cladochonus sp.

An undetermined species of this genus is one of the most abundant and characteristic fossils of the lower Portage.

Aulopora sp.

A species of *Aulopora* attached to the valves of brachiopods is common at many localities in the Ithaca group and in the upper *Spirifer lævis* zone of the Portage.

Stromatopora sp.

This genus has been reported by Prof. Williams from the Ithaca group.

Stictopora meeki Nicholson.

A very abundant fossil throughout the Ithaca group.

Zaphrentis simplex? Hall.

Specimens resembling this species have been found at a single locality in a calcareous sandstone in Williams Creek section.

Callopora sp.

I have found an undetermined species of this genus occurring abundantly in a calcareous stratum at station 10–5.

Echinodermata.

Taxocrinus ithacensis H. S. W.

A single perfect specimen from the Ithaca group at station 7–10 has been found.

Arthroacantha ithacensis H. S. W.

This crinoid is rather common at station 1–13 in the upper part of the Ithaca group. The original specimens came from the bottom of the gorge below Triphammer falls.

Poteriocrinus cornellianus H. S. W.
Reported by H. S. Williams from the Ithaca group.

Poteriocrinus clarkei var. *alpha* H. S. W.
Lower Ithaca group.—H. S. Williams.

Poteriocrinus (*Decadocrinus*) *gregarius* H. S. W.
Ithaca group.—H. S. Williams.

Poteriocrinus (*Decadocrinus*) *zethus* H. S. W.
Portage group?—H. S. Williams.

Taxocrinus ithacensis var. *alpha* H. S. W.
Ithaca group.—H. S. Williams.

Taxocrinus curtus H. S. W.
Portage group.—H. S. Williams.

Molluscoidea and Mollusca.

Brachiopoda.

Discina neglecta Hall.
Upper Ithaca group.

Discina grandis? Hall.
Specimens which appear to belong to this species occur in the Ithaca group.

Lingula complanata H. S. W.
Abundant in the Ithaca shale.

Lingula punctata Hall.
Ithaca shale.

Lingula spatulata Hall.
Ithaca shale.

Lingula ligea Hall.
Ithaca shale.

Crania sp.
A species of *Crania* resembling *C. hamiltoniæ* occurs through the Portage and Ithaca rocks.

Cyrtina hamiltonensis Hall.

Very abundant in the upper part of the Ithaca group.

The large number of specimens of this species which have been examined show but slight tendency to vary, except in size. Average specimens have a width of about ½ inch along the hinge line; the longest noticed measured seven-tenths of an inch.

Ambocœlia umbonata Conrad.

Abundant in the Ithaca group.

Strophodonta mucronata Hall.

Very abundant in the upper Ithaca group. It also occurs through most of the Portage.

Strophodonta perplana var. *nervosa* Hall.

Occurs in the Ithaca group but is less common than the preceding.

Strophodonta demissa? Con.

A rare species in the Ithaca group.

Productus (*Productella*) *hallanus* Walcott.

Two or three specimens of this species have been found in the upper part of the Ithaca group.

Productella speciosa Hall.

This is an abundant and characteristic species of the Ithaca group. The larger specimens measure from four-fifths to one inch in width. The most abundant species associated with it in the Ithaca group are *Strophodonta mucronata*, *Spirifer mesacostalis*, and *Cyrtina hamiltonensis.*

Productella truncata Hall.

This is a common species in the Ithaca shale. It seems to differ from *P. speciosa* only in size, some specimens measuring not more than one-tenth of an inch, while those of average size are from three-tenths to two-fifths of an inch in width. In the lower part of the Ithaca group, forms occur which seem to be intermediate between *P. truncata* and *P. speciosa.*

Spirifer mesacostalis Hall.

Abundant in the Ithaca group. *S. mesacostalis* shows a large amount of variation in specimens from the same horizon. Variation occurs principally in connection with four different characters,—the number of plications, the extent of the hinge line, the character of the median fold, whether single or duplicate, and the presence or absence of a plication in the sinus. In fifty specimens examined, from 200 to 385 feet above the upper Portage *S. lævis* zone, the number of plications varied from 12 to 24, the average number being 16. A very small per cent., perhaps one in 50 or 60, of specimens from the horizon of Triphammer falls and Eddy's dam (385 feet above the *S. lævis* zone) show a duplicate median fold, and about the same number show a trace of a plication in the sinus. Neither of these characters have been noticed in specimens from below this horizon. All of the specimens which were properly preserved, show the distinct median septum extending nearly through the muscular scars in the ventral valve. The greatest amount of variation, however, is in the extent of the hinge line. In some specimens, the hinge line does not extend beyond the margin of the valves, while in others its delicate spine-like projections more than equal the width of the valves.

Spirifer lævis Hall.

Prof. Williams has reported this species from the upper part of the Ithaca group and the writer has found several specimens of it 130 feet below the upper Portage *S. lævis* zone, so that this species is now known to have a vertical range of not less than 500 feet.

Spirifer fimbriata Morton.

Lower part of the Ithaca group.—H. S. Williams.

Spirifer angusta Hall.

Lower Ithaca group.—H. S. Williams.

Spirifer mesastrialis Hall.

This is a very abundant species in the Ithaca group. It has not been found in the Portage.

Orthis impressa Hall.

This is one of the characteristic fossils of the Ithaca group. Most specimens have the length and breadth nearly equal, both dimensions averaging 1¼ inches. The Chemung form of this species differs from that at Ithaca, according to Prof. Williams, by having the shell wider than long.

Rhynchonella (*Stenoschisma*) *eximia* Hall.

Occurs through the greater part of the Ithaca group.

The forms described as *R. eximia* and *R. stephani* appear to be varieties of the same species. The larger specimens sometimes have a width of one inch, and the strong angular plications characteristic of *R. stephani*. The ratio of length and breadth varies considerably in different individuals; generally the length is slightly greater than the width, but in some individuals the length and breadth have the ratio of 8 to 11. The majority of the specimens are not more than ¼ to ½ inch in width and have the finer plications of *R. eximia*.

Rhynchonella contracta Hall.

Lower part of the Ithaca group.

Ryhnchonella pugnus Martin.

This species which has heretofore been known only in the Ithaca fauna, I have found in the Portage below the upper *Spirifer lævis* zone.

Leiorhynchus mesacostalis Hall.

This species is very abundant in the Ithaca group, occurring in some layers almost to the exclusion of other species. The specimens vary greatly in size, the largest measuring about 1½ inches at the greatest width, while average specimens measure about ¾ of an inch. *Leiorhynchus sinuatus* is probably a small variety of this species.

Cryptonella eudora Hall.

This species appears to have a very limited vertical range. It occurs abundantly near the middle of the Ithaca group.

Atrypa reticularis Hall.

This species becomes abundant in the upper part of the Ithaca group. It seems to be entirely absent from the Portage and the lower part of the Ithaca fauna.

Atrypa aspera Hall.

Abundant at a few localities in the upper part of the Ithaca group.

Chonetes lepida Hall.

This is a common Portage species. It occurs in the Ithaca group, but less frequently.

Chonetes scitula Hall.

Specimens of the *C. scitula* type occur associated with *C. seti-*

gera, but are much less common than the latter. This species seems to be a variety of *C. setigera;* the same is probably, but less certainly, true of *C. lepida.*

Pteropoda.

Tantaculites spiculus Hall.

This is a rare species in the Ithaca group.

Styliolina fissurella Hall.

This species is recorded by Williams from the Portage and the lower part of the Ithaca group.

Coleolus aciculum Hall.

Common in the Portage and the Ithaca shale.

Hyolithes aclis Hall.

Lower Portage.—H. S. Williams.

Conularia congregata Hall.

Occurs in the Ithaca shale rarely; more common in the middle and upper part of the Ithaca group.

Coleoprion sp.

This genus is recorded by Williams from the upper *Spirifer lævis* zone of the Portage.

Gastropoda.

Euomphalus (*Straparollus*) *hecale* Hall.

Ithaca group.—H. S. Williams.

Pleurotomaria capillaria Hall.

Common through the Portage and Ithaca groups.

Loxonema delphicola Hall.

This species is common in the lower part of the Ithaca group above the Ithaca shale.

Bellerophon leda Hall.

This is a rather rare species in the upper part of the Ithaca group.

Bellerophon explanatus? Hall.

A few specimens from the upper part of the Ithaca group, stations 2–9, 2–14, and 2–16, are referred with doubt to this species. They are much smaller than the specimen figured by Hall, and have the dorsum flat instead of rounded as in that species.

Bellerophon ithacensis n. sp., Pl. 1, figs. 1, 2.

The specimens on which this species is based are somewhat distorted and crushed.

Shell of medium size. Width of flattened specimen greater than the length. The aperture is considerably expanded. Volutions apparently not more than one or two. The dorsum is marked with a sharp elevated carina.

The surface is marked by a peculiar wrinkling, varying in its development from roughly transverse striæ to a pustulose or reticulate surface.

The ornamentation of this species is unique, readily distinguishing it from any other of the genus.

From the Ithaca group, station 1–13.

Macrocheilus (*Holopea*) *macrostomus?* Hall.

A single well-preserved specimen of this genus has been obtained from station 6–1, in the lower part of the Ithaca group.

Platystoma lineatum var. *callosum* Hall.

This gastropod is rather common in the University quarry associated with *Spirifer mesacostalis* and *S. mesrstrialis*.

Platyceras carinatum Hall.

Common at a few localities in the Ithaca group.

Cephalopoda.

Orthoceras fulgidum Hall.

This is rather rare in the Ithaca group.

Orthoceras leander Hall?

A few specimens from the Ithaca group are referred to this species.

Orthoceras pecator Hall.

Two specimens were obtained from the Ithaca group at station 2–12.

Orthoceras anguis Hall.

Occurs in the upper *Spirifer lævis* zone of the Portage.

Orthoceras demus Hall.

Specimens referred to this genus were found in the Ithaca group at station 1–11.

Orthoceras leander Hall.

From the Ithaca group.

Orthoceras pertextum Hall.

This species is recorded from the Ithaca group by Hall.

Orthoceras bebryx var. *cayuga* Hall.

This is the most abundant species of *Orthoceras* found at Ithaca. It ranges throughout the Ithaca group.

Gomphoceras tumidum Hall.

This species is rather common in the Ithaca group. A small variety of it occurs in the upper *Sp. lævis* zone of the Portage.

Porcellia nais Hall.*

This is a rare species occurring occasionally in the Ithaca group.

Goniatites sinuosus Hall.

This species ranges from the lower Portage through the Ithaca group.

Goniatites peracutus Hall.

A single well preserved specimen from station 4–2, about fifteen feet above the *Spirifer lævis* zone. (Omitted in list, p. 23).

Goniatites complanatus Hall.

This is a common species in the Portage.

Goniatites discoideus Hall.

Common in the Portage.

Goniatites simulator Hall.

Ithaca group.—Hall.

Goniatites uniangularis Con.

Some specimens from the Ithaca group are doubtfully referred to this species.

Pelecypoda.

Phthonia cylindrica Hall.

A single entire specimen of this species has been found at station 6–1 in the Ithaca shale. It has not been reported before from the Ithaca group.

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* Classed by the writer among cephalopods, doubtless by mistake.—Ed.

Phthonia lirata Hall.
Ithaca shale.—H. S. Williams.

Pholadella radiata Hall.
Ithaca group.—Hall.

Spathella typica Hall.
Common in the Portage and Ithaca groups.

Schizodus chemungensis Hall.
This is a common species in the upper part of the Ithaca group at Ithaca.

Schizodus chemungensis var. *quadrangularis* Hall.
A few specimens have the distinctly erect form of the variety described as *quadrangularis* by Hall.

Glossites depressus Hall.
This species occurs in the *Spirifer lævis* zone, and is occasionally found in the Ithaca group.

Grammysia subarcuata Hall.
This is a common species throughout most of the Ithaca group. It also occurs in the upper Portage.

Prof. Hall has recorded the three following species of *Grammysia* from the "lower Chemung" at Ithaca: *Grammysia magna* Hall, *G. circularis* Hall, and *G. elliptica* Hall.

Goniophora minor Hall.
Rather common in the Ithaca group.

Goniophora hamiltonensis Hall.
This species occurs in the Ithaca group, but less commonly than the preceding.

Edmondia subovata Hall.
Common in the upper part of the Ithaca group.

Microdon (*Cypricardella*) *bellistriatus* (Conrad) Hall.
Common throughout most of the Ithaca group. It has not been found in the Portage.

Microdon gregarius Hall.
This species is associated with the former, but is less common.

Microdon tenuistriatus Hall.

From the lower part of the Ithaca group.—H. S. Williams.

Conocardium liratum Hall.

This species is reported from the Ithaca group by Prof. Hall.

Glyptocardia speciosa Hall.

This species which is a characteristic and abundant Portage fossil, has been found in a recurrent Portage fauna above the Ithaca group; found occasionally in the midst of the Ithaca fauna.

Ptychodesma nanum Hall.

Ithaca group.—Hall.

Panenka sp.

Two imperfect specimens of this genus have been found in the Ithaca group in the Fall Creek section.

Macrodon chemungensis? Hall.

Specimens corresponding to the species except in surface marking, occur sparingly in the upper part of the Ithaca group. The surface of the shell is marked by indistinct concentric striæ which are almost obliterated by reticulating lines which mark the surface of the shell with regular rows of small pustules, giving it a distinctly reticulated appearance.

Pararca sp.

A few fragmentary specimens of this genus have been found in the Ithaca group.

Nucula diffidens Hall.

This is a common species in the Portage and Ithaca groups.

Nucula corbuliformis Hall.

A few specimens occur associated with *N. diffidens* which appear to be identical with *N. corbuliformis* of the Hamilton.

Nucula lamellata Hall.

This is apparently a rare species in the Ithaca group. Two specimens.

Nuculites triqueter Con.

A single good specimen of this species was obtained from station 7–10 in the Ithaca group.

Palæoneilo constricta (Conrad) Hall.

This is a very common fossil of the Portage and Ithaca groups, occurring at nearly every station, and usually associated with *P. filosa*. It varies greatly in form and size.

The specimens referred to this species include many which correspond to Hall's figures of *P. maxima*, but which seem to be only variations of the *P. constricta* type.

Palæoneilo constricta var. *flexuosa* (Conrad) Hall.

Ithaca group.—Hall.

Palæoneilo filosa Con.

This is a common species of the Portage and Ithaca groups. It shows comparatively little tendency to variation. Well preserved specimens show distinct, fine striæ between the coarser ones on the posterior part of the shell, similar to *P. fecunda*.

Palæoneilo plana Hall.

This species occurs in the Ithaca group, but is much less common than the two preceding.

Palæoneilo emarginata? (Conrad) Hall.

Two imperfect specimens from the Ithaca group are referred to this species.

Leda diversa Hall.

This species is rather common in the Portage and Ithaca groups.

Leda curta? Meek.

Lower Portage.—H. S. Williams.

Leda perstriata Hall.

Upper *Spirifer lævis* zone.—H. S. Williams.

Modiomorpha subalata var. *chemungensis* Hall.

This is one of the most abundant species in the Ithaca group.

Modiomorpha subalata Hall.

Some specimens from the Portage and Ithaca groups correspond to *M. subalata* of the Hamilton.

Modiomorpha concentrica Hall.

A few specimens have been found in the Ithaca group.

Modiomorpha complanata Hall.

From the lower part of the Ithaca group.—H. S. Williams.

Modiomorpha neglecta? Hall.

A single specimen from station 7–10 is referred to this species.

Mytilarca chemungensis Hall.

This species is common at station 4–5, and from a few localities in the Ithaca group.

A single specimen from the *Spirifer lævis* bed at Ithaca falls differs from the ordinary specimens of *M. chemungensis* in its erect form and small size.

Mytilarca umbonata Hall.

From the Ithaca group.—Hall.

Leptodesma sociale Hall.

This is a characteristic species of the Portage and Ithaca shale, and occurs less frequently in the Ithaca group. Different individuals show great variation in the extension of the wing, the gibbosity of the shell, and the obliquity of the body. Some specimens correspond closely to Hall's figures of *L. potens* and *L. potens* var. *juvens*, but they probably represent variations of *L. sociale*.

Leptodesma sp?

Imperfect specimens of one or two large species of *Leptodesma* have been found in the upper part of the Ithaca group.

Leptodesma naviforme Hall.

From the Ithaca group.—Hall.

Pterinea (*Vertumnia*) *reproba* Hall.

Common in the upper part of the Ithaca group.

Pterinopecten erectus Hall.

This is a rare species. A few specimens have been obtained from the Ithaca group at the University quarry and in Fall creek.

Pterinopecten suborbicularis Hall.

Occurs in the Ithaca group.—H. S. Williams.

Aviculopecten cancellatus Hall.

From the Ithaca group.—H. S. Williams.

Aviculopecten fasciculatus Hall.

This species is rather rare in the Ithaca group. One specimen referred to this species is from station 2–14.

Aviculopecten striatus? Hall.

Specimens which appear to belong to this species are found occasionally in the Ithaca group.

Aviculopecten rugæstriatus? Hall.

A few specimens which are found in the Portage and Ithaca groups are doubtfully referred to this species.

Aviculopecten lautus var. **ithacensis** n. var., Pl. 1, fig. 3.

The specimen on which this variety is based differs from *A. lautus*, figured by Hall, in having the beak prominent, the hinge line much shorter than the width of the shell, very distinct concentric striæ, and only a portion of the strong rays with intermediate finer ones.

The left valve has a width of nine-twentieths and a height of two-fifths of an inch.

From the Portage at the foot of Ithaca falls.

Actinopteria sp.

Specimens of this genus are common through the Ithaca group and upper Portage. Prof. Hall has described ten species of *Actinopteria* from Ithaca. These probably represent variations of two or three species. All I have seen I have been able to refer to the three following species:—

Actinopteria tenuistriata Hall.

A few specimens from the Portage and the lower part of the Ithaca group are referred to this species.

Actinopteria boydi Hall.

Typical specimens of this species are abundant at Triphammer and other localities in the upper Ithaca fauna.

Actinopteria perstrialis Hall.

Specimens referred to this species are common in the Portage and Ithaca rocks.

The points of difference made by Hall between his Ithaca species of *Actinopteria*, are shown in the following synopsis of their characters:—

Analytical key to the species of Actinopteria.

A. Body nearly erect, broadly ovate; hinge line extended.
  A. Concentric striæ crenulating the rays and bending back in the interspaces. *Actinopteria zeta.*
  A'. Concentric striæ not crenulating the rays nor bending back in the interspaces; form quadrate. *A. tenuistriata.*

B. Body not very oblique.

B. Surface marked by concentric striæ which curve backward between the radii.

β1. Strong radii, usually without interstitial additions. *A. boydi.*

β2. Slender radii with interstitial additions.

b1. Body broadly ovate; oblique, at an angle of about 55°. *A. theta.*

b2. Body broad and short ovate; oblique, at an angle of about 45°. *A. eta.*

B′. Surface not marked by concentric striæ which curve backward between the radii.

β′1. Strong elevated rays and wider interspaces. *A. epsilon.*

β′2. Radii, fine.

b′1. Body at an angle of about 60° with the hinge. *A. delta.*

b′2. Body at an angle of about 45° with the hinge.

b′1. Shell small, body subrhomboidal, subovate. *A. perstrialis.*

b′2. Shell of medium size, rhomboidal, body broadly ovate. *A. iota.*

C. Body very oblique.

Radii filiform, interrupted and undulating. *A. kappa.*

Crustacea.

Phacops rana Hall.

This species is abundant at a single locality in the Ithaca group, station 8–4.

Mesothyra oceani Hall.

This is a rare species in the Portage group.

Vertebrata.

Pisces.

Dipterus ithacensis H. S. W.

Lower Ithaca group and Ithaca shale.—H. S. Williams.

Plantæ.

Plumulina plumaria Hall.

This species occurs abundantly at many localities in the Ithaca group. I have also found it in the upper *Spirifer lævis* fauna at Glenwood.

Psilophyton princeps Dawson.

Common in the Ithaca shale and Portage group.

Rachiopteris punctata Dawson.

Occurs in the Ithaca shale.—H. S. Williams.

Lepidodendron sp.

Fragments of a species of *Lepidodendron* have been found in the Ithaca group at station 8–4.

TYPICAL CHEMUNG FAUNA.

The Chemung fauna does not occur in any of the Ithaca sections, but the following list represents it at the typical locality, near Chemung village, as determined by Prof. Williams*:—

Orthis tioga, *Streptorhynchus chemungensis*, *Aviculopecten pecteniformis* Hall, *Pterinea chemungensis* (Con.) H. S. W., *Strophodonta cayuta*, *S. demissa*, *Productella lachrymosa* var. *lima*, *P. costatula*, *Spirifer disjunctus*, *Ambocœlia umbonata* var. *gregaria*, *Atrypa reticularis*, *Rhynchonella contracta*, *Leiorhynchus sinuatus*, *L. mesacostalis*, *Cryptonella eudora*, *Pteronites spinigerus* Con., *Pterinea protexta* Con., *Avicula multilineata* Con., *Cypricardites* (*Goniophora*) *chemungensis*, *Schizodus* (*Nuculites*) *chemungensis* (Con.), *Grammysia subarcuata* H. & Whit.

The rare species are *Chonetes setigera*, *C. illinoisensis?*, *Pleurotomaria capillaria*, *Euomphalus* sp., *Collonema* sp., *Rhynchonella sappho*, *Orthis michelini* L'Ev. (if distinct from *O. vanuxemi*), *Glyptodesma* sp., *Bellerophon mæra*, *Platyceras* sp., *Cyclonema* sp., *Orthis carinata*, *O. leonensis*, *Knorria* sp., *Cladochonus* sp., *Strophodonta perplana* var. *nervosa*, *Taxocrinus ithacensis*, *Gomphoceras* sp., *Spirifer fimbriata*, "*Fucoides graphica*," *Spirifer mesacostalis* (2d var.), *Atrypa aspera*, *Orthis impressa* (wide var.), *Rhynchonella orbicularis*, *Discina grandis*, *Mytilarca chemungensis*.

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* Bull. U. S. Geol. Surv., No. 3.

PART IV.

SUMMARY.

The detailed lists of the preceding pages show that we have represented here four faunas. The work of Dr. H. S. Williams* has left little to be done in determining their composition and order of sequence. The efforts of the writer have therefore been directed toward ascertaining the extreme limits of the vertical range of the several species beyond their zone of culmination, by a minute study of several sections. A precise knowledge of the vertical range of the dominant species of a fauna is very essential to a correct interpretation of its history. If the principal species of a fauna can be shown to be entirely absent from the beds below it, then it may be considered a migratory fauna. The scarcity of the principal representatives of a fauna below their horizon of culmination might give a locally developed fauna the appearance of having migrated into a region.

The principal result of this study has been to extend the vertical range of some of the well known species of these faunas, and to determine more definitely that of others. The range of a number of these is shown by the table. By reference to the same, it will be seen that two of the most abundant and characteristic Portage species, *Glyptocardia speciosa* and *Lunulicardium fragile*, have been found in the midst of the Ithaca group. One of the most interesting of such forms here—*Spirifer lævis*—has been found 110 feet below the well known zone at the base of Ithaca falls. Some of the species of the Ithaca fauna not previously known below it, have been found in the Portage rocks. One of the most interesting of these is *Ryhnchonella pugnus* Martin, which I have found at station 7–5. *Plumulina plumaria* has been found at a few localities associated with *Spirifer lævis* near the middle of the Portage.

The number of recurrent Hamilton fossils previously known from the Ithaca group has been increased by the discovery of some additional species. These are *Phacops rana*, which occurs abundantly in a single layer in the Ithaca group (station 8–4), *Orthis vanuxemi*, also abundant at a single locality (station 6–1), *Modiomorpha mytiloides*, *Nuculites triqueter*, *Strophodonta perplana*, *Phthonia cylindrica*.

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* Bull. U. S. Geol. Surv., No. 3.

A comparison of the Ithaca and Portage faunas shows that nearly all of the typical Portage species occur, though less abundantly, in the Ithaca fauna. Some of the most abundant species of the Ithaca fauna, *Cyrtina hamiltonensis* and *Strophodonta mucronata*, are present in the Portage. A few of the most distinctive species of the Ithaca fauna as *Cryptonella eudora* and *Spirifer mesacostalis*, are not found in the Portage and the Ithaca shale. The prevalence of the Ithaca shale conditions and the *Lingula* fauna probably led to the shifting of some of the Portage species, since they appear to be absent from the Ithaca shale; with the return of sandy sediments, the Portage species, some of which were thinned almost to extinction, were accompanied by Hamilton species which were probably derived from the east and by others not before known from the New York system, giving rise to the cosmopolitan Ithaca fauna.

An examination of the Chemung fauna also reveals its close relationship to the Ithaca fauna. Several of the species are common to both. There is, however, a smaller per cent. of species common to the Chemung and Ithaca, than of those common to the latter and the Portage fauna. This together with the fact that Portage species occur in the Ithaca group, and that a typical Portage fauna occurs above the Ithaca, seem to indicate that the latter has a closer relationship to the Portage and shouldbe classed in the Portage epoch.

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Plate I.

EXPLANATION OF PLATE 1.

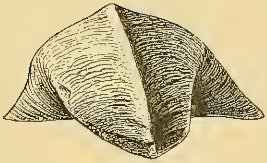
(1)

Page.

Fig. 1. *Bellerophon ithacensis* n. sp., x2........................ 39, **39.**
Dorsal view.

2. *Bellerophon ithacensis* n. sp., x2........................ 39, **39.**
Showing part of peristome.

3. *Aviculopecten lautus* var. *ithacensis* n. var., x2.. 45, **45.**
Left valve.



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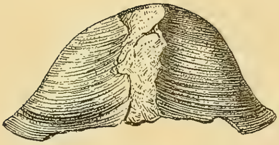

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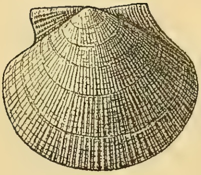

3

ERRATA.

Page 18, line 6: for *Plumaria plumulina* read *Plumulina plumaria*.
“ 18, “ 13: do do
“ 25, “ 1: for sondstone read sandstone.
“ 39, “ 22: for *S. mesrstrialis* read *S. mesastrialis*.
“ 51, “ 15: for Devo- read Devonian.
“ 52, “ 14: for py. read pp.

We regret to say that Part III does not contain a discussion of all the species mentioned by the writer in Part II. *Lunulicardium fragile* is perhaps the most serious omission.—Ed.

Smithsonian Institution,
JAN 19 1910
National Museum.

Vol. 2

BULLETINS
OF
AMERICAN PALEONTOLOGY

No. 7

A BIBLIOGRAPHY OF THE GEOLOGICAL, MINERALOGICAL AND PALEONTOLOGICAL LITERATURE OF THE STATE OF VIRGINIA

BY

THOMAS L. WATSON
Fellow in Cornell University

February 10, 1897

Ithaca, N. Y.
U. S. A.

A BIBLIOGRAPHY OF THE GEOLOGICAL, MINERALOGICAL AND PALEONTOLOGICAL LITERATURE OF THE STATE OF VIRGINIA.

BY

Thomas L. Watson.

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- **Mineralogy and Petrography**.........................104–105
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INTRODUCTION.

The author has for several years past been collecting and noting all references to literature bearing on the geology of the State of Virginia, with a view to publishing such memoranda sooner or later, mainly, for the convenience of future workers in the State. All workers in this State must have recognized the inaccessibility of a large part of the literature, caused by its greatly scattered condition, which is due almost entirely to the fact that, with few exceptions, all contributions have been made by individuals working independently of any organization. Their results were donated to and have been published in papers or periodicals of a more or less local character, and in some cases even these were of a brief existence. Apart from the unfortunately short-lived State Geological Survey, under the directorship of Professor William Barton Rogers—established during the year 1835 and continuing through 1841—and of recent years, the work of the United States Geological Survey, which has had parties in that field during each season, there has been and is yet an entire absence of any organization or journal devoted to either general or special science in the State. Major Jed. Hotchkiss, of Staunton, Virginia, edited, during the years 1880–1885, a journal entitled, "The Virginias," and while it contained a large number of valuable contributions to Virginia as well as West Virginia geology, it was largely, if not exclusively, devoted to mining and engineering.

The literature is not by any means very extensive, or even approaching what might be termed voluminous, when compared with that of some of the other states, but the above conditions have certainly conspired to render its summation a very tedious and laborious task, carrying with it a considerable element of incompleteness.

This list is published under the title "Bibliography," but it might perhaps have been more correct to have inserted the word, "Partial," inasmuch as it is not a complete record of all the work; however, I feel safe in saying that it does represent by far the greater bulk of the material thus far contributed. I have avoided, as far as possible, the mere mention of Virginia in articles bearing on the geology of other territories. This has not been strictly adhered to in all cases, since many articles of much importance have been found in which reference, though very brief, was made to Virginia and which fully warranted their listing in this paper. This element is further increased, when the writings of the earlier workers are examined, as the work was done in what then was called Virginia, but since admitted into the Union as a separate state and is known as West Virginia, hence many of the earlier references which occur in this bibliography would more correctly find classification with the West Virginia literature.

I publish this with the hope of having my attention called to any and all publications which may have been omitted, by those who may find omissions. Since this paper has gone to press, I have had access to several publications containing a large amount of geologic material which has necessitated a rather large addenda.

I wish to make acknowledgments to many who have aided me in this publication, but especially to Prof. G. D. Harris, of Cornell University, who has constantly aided me in many ways by invaluable suggestions, and particularly by kindly accepting this as one of his series of Bulletins, insuring thereby prompt publication.

LIST OF THE PRINCIPAL JOURNALS CONSULTED; With Abbreviations.

Amer. Jour. Sci., or A. J. S.—The American Journal of Science, sometimes called Silliman's Journal.
Amer. Nat.—The American Naturalist.
Amer. Chem. Jour.—The American Chemical Journal.
Amer. Geol.—The American Geologist.
Ann'l Rep't Smithsonian Inst.—Annual Report of the Smithsonian Institution.
Ann'l Rep't U. S. Geol. Surv.—Annual Report of the United States Geological Survey.
Ann'l Rep't Geol. Surv. Pa.—Annual Report of the Geological Survey of Pennsylvania.
Ann'l Rep't Geol. Surv. Va.—Annual Report of the Geological Survey of Virginia.
An. Lyc. Nat. Hist. N. Y—Annals of the Lyceum of Natural History of New York.
Bull. Geol. Soc. Amer.—Bulletin of the Geological Society of America.
Bull. Geol. Soc. France.—Bulletin of the Geological Society of France.
Bull. Phil. Soc. Wash.—Bulletin of the Philosophical Society of Washington, D. C.
Bull. U. S. Geol. Surv.—Bulletin of the United States Geological Survey.
Census U. S.—Census Report of the United States.
Chem. News.—The Chemical News, London.
Engr. and Min. Jour.—The Engineering and Mining Journal.
Geol. Mag.—The Geological Magazine, London.
Geol. Record.—The Geological Record, London.
Geol. Soc. Wash.—The Geological Society of Washington, D. C.
Jour. Chem. Soc.—Journal of the Chemical Society, London.
Jour. Acad. Nat. Sci. Phila.—Journal of the Academy of Natural Sciences, Philadelphia.
Jour. Geol.—Journal of Geology, Chicago.
J. H. Univ. Cir.—Johns Hopkins University Circulars.

McFarlane's Geol. Ry. Guide.—McFarlane's Geological Railroad Guide.

Mem. Amer. Acad. Arts and Sci.—Memoirs of the American Academy of Arts and Sciences.

Min. Res. U. S.—Mineral Resources of the United States.

Min. Jour.—Mining Journal of London.

Mon. U. S Geol. Surv.—Monograph of the United States Geological Survey.

Pop. Sci. Mon.—The Popular Science Monthly.

Proc. Amer. Phil. Soc.—Proceedings of the American Philosophical Society, Philadelphia.

Proc. Amer. Assoc. Adv. Sci., or A. A. A. S.—Proceedings of the American Association for the Advancement of Science.

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The following is the explanation of the figures:—

FIG. I (p. 163). Map or ground plan of an Estate called "Rappahannock or Smith's Gold Mine" in Stafford County, Virginia.

FIG. II (p. 164). Transverse section of the vein or load when looking towards the north-east in the shafts Nos. 3 and 4.

FIG. III (p. 165). Longitudinal section of the country in the direction of the central vein, taken by eye estimation without instruments.

FIG. IV (p. 166). Transverse section of the vein or load when looking towards the north-east in the deep shaft No. 10.

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No. 13. Fredericksburg—Maryland, Virginia.
No. 14. Staunton—Virginia, West Virginia.
No. 23. Nomini—Maryland, Virginia.
No. 26. Pocahontas—Virginia, West Virginia.
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1782. Marquis de Chastelleux.
1783. Lincoln, B.
1793. Greenway, J.
1799. Hewson, Dr., Latrobe, B. H., Williams, J.
1806. Chevallie, J. A.
1817. Maclure, W.
1818. Gilmer, F. W.
1819. Cornelius, E., Grammer, J., Kain, J. H.
1821. Nuttall, T.
1825. Jefferson, Thos.
1834. Rogers, H. D., Rogers, J. B., Rogers, W. B.
1835. Clemson, T. G., Featherstonhaugh, G. W., Rogers, W. B.
1837. Prolix, P.
1839. Daubeny, C.
1840-42. Rogers, H. D., Rogers, W. B.
1843. Hayden, C. B., Murchison, R. I.
1848. Rogers, W. B.
1854. Rogers, W. B.
1854-56. Rogers, W. B.
1855. Rogers, W. B.
1859-61. Rogers, W. B.
1862. Lesley, J. P.
1868. Maury, M. F.
1869. Safford, J. M.
1870. Shaler, N. S.
1871. Lesley, J. P., Shaler, N. S.
1873. Hunt, T. S., Stevens, R. P.
1874. Fontaine, W. M., Hunt, T. S.
1875. Ansted, D. T., Fontaine, W. M., Rogers, W. B., Stevenson, J. J., Webster, N. B.
1876. Abert, S.T., Fontaine, W. M., Hotchkiss, J., Wallace, C.M.
1877. Young.
1878. Hotchkiss, J.
1879. Campbell, J. L., Chickering, jr., J. W., McDonald, M., Stevenson, J. J.
1880. Campbell, J. L., McDonald, M., Stevenson, J. J.

1881. Dunnington, F. P., Fontaine, W. M., Hotchkiss, J., Lewis, H. C., Stevenson, J. J., White, C. A.
1882. Dunnington, F. P., Fontaine, W. M., Hitchcock, C. H., Hotchkiss, J., Lesley, J. P., Rogers, W. B.
1883. Hotchkiss, J., Kerr, W. C., Smock, J. C., White, I. C.
1884. Ashburner, C. A., Campbell, J. L., Hotchkiss, J., Rogers, W. B., Stevenson, J. J., Warner, C. D.
1885. Ashburner, C. A., Campbell, J. K., Dunnington, F. P., Fontaine, W. M., Hotchkiss, J., McGee, W J.
1886. McGee, W J.
1887. Britton, N. L., Claypole, E. W., McGee, W J, Stevenson, J. J., White, I. C.
1888. Clifford, W., McGee, W J, Shaler, N. S., Willis, B.?
1889. Clifford, W., Clinch, Curtice, C., McGee, W J, Russell, I. C., Shaler, N. S.
1890. Chester, F. D., Darton, N. H., Diller, J. S., McGee, W J, Minor, F., Woolman, L.
1890-91. McGee, W J.
1891. Darton, N. H., Davis, W. M., Geiger, H. R., Keith, A., Hayes, C. W., Hitchcock, C. H., Lindenkohl, A., McGee, W J., Russell, I. C., Shaler, N. S., Spencer, J. W., Williams, G. H., Willis, B.
1891-92. Gannett, H., Willis, B.
1892. Baskerville, C., Keith, A., Mitchell, R. H.
1893. Cobb, C., Darton, N. H., Keith, A., Stevenson, J. J., Whitehead, T.
1894. Bache, F., Campbell, M. R., Darton, N. H., Shaler, N. S., Spencer, J. W.
1895. Spencer, A. C.
1896. Campbell, M. R., Hayes, C. W., Schmitz, E. T., Willis, B.

Paleontology and Stratigraphic Geology.

1774-1848. Greenway, J.
1783. Lincoln, B.
1798. Beauvois, M., Jefferson, T.
1799. Jefferson, T.
1824. Finch, J.
1826. Pierce, J.
1829. Morton, S. G.
1832. Lea, I.
1833. Conrad, T. A.

1834. Brongniart, Conrad, T. A., Morton, S. G., Rogers, H. D.
1835. Conrad, T. A., Rogers, H. D., Rogers, W. B., Taylor, R. C.
1836. Hildreth, S. P., Morton, S. G.
1839. Rogers, H. D., Rogers, W. B.
1840. Rogers, W. B.
1840-42. Bailey, J. W., Conrad, T. A., Hodge, J. J., Rogers, H. D., Rogers, W. B.
1841. Redfield, W. C.
1841-43. Bailey, J. W., Murchison, R. I., Rogers, H. D.
1842. Conrad, T. A., Lyell, C., Tuomey, M.
1843. Lea, H. C., Rogers, W. B.
1844. Bailey, J. W., Rogers, W. B.
1845. Lonsdale, W., Lyell, C.
1847. Bunbury, C. J. F.
1848. Conrad, T. A.
1849. Lyell, C.
1850. Ruffin, E.
1850-54. Leidy, J., Wyman.
1852. Lyell, C.
1852-53. Leidy, J.
1853. Hitchcock, E.
1854. Rogers, W. B.
1854-56. Rogers, W. B.
1858-60. Gabb, W. M.
1859. Leidy, J.
1859-61. Rogers, W. B.
1860. Rogers, W. B.
1863. Meek, F. B.
1864. Conrad, T. A.
1865. Conrad, T. A,
1867. Cope, E. D.
1873. Leidy, J.
1874. Fontaine, W. M.
1874-78. Meek, F. B.
1875. Bradley, F. H., Fontaine, W. M.
1876. Coryell, M., Stodder, C., White, I. C.
1877. Fontaine, W. M.
1878. Fontaine, W. M., Heinrich, O. J., White, I. C.
1879. Campbell, J. L., Fontaine, W. M., Heilprin, A., Kingsley, J. S., Rogers, W. B.
1880. Campbell, J. L., Coryell, M., Page, W. N., Rogers, W. B., Russell, I. C.

1881. Bailey, J. W., Campbell, J. L., Miller, S. A., Stodder, C.
1882. Fontaine, W. M., Heilprin, A., Hunt, T. S., Lewis, H. C., Lesley, J. P., Rogers, W. B.
1883. Elliott, J. B., Fontaine, W. M., Rogers, W. B.
1883-84. White, C. A., Heilprin, A., Ryder, J. A.
1884. Heilprin, A., Hunt, T. S., McCreath, A. S.
1884-86. Rogers, H. D.
1884-95. Heilprin, A.
1885. Campbell, H. D., Duncan, P. M., Lyell, C., McGee, W J.
1886. Newberry, J. S.
1886-87. Ward, L. F.
1887. Lesquereux.
1888. Clarke, J. M., Hall, J., Marsh, O. C., McGee, W J, Meyer, O., Newberry, J. S., Ward, L. F., Zeiller, R.
1888-89. Walcott, C. D.
1889. Dall, W. H., Fontaine, W. M., Knowlton, F. H., Russell, I. C., Stur, D.
1890. Clark, W. B., Dall, W. H., Lacoe, R. D., Marcou, J., McGee, W J.
1890-91. McGee, W J.
1891. Clark, W. B., Darton, N. H., Eyerman, J., Prosser, C. S., Walcott, C. D., White, C. A., White, I. C., Williams, H. S.
1892. Dall, W. H., Darton, N. H., Harris, G. D., Russell, I. C., Stevenson, J. J., VanHise, C. R., Walcott, C. D.
1893. Clark, W. B., Dall, W. H., Harris, G. D., Walcott, C. D.
1893-94. Ward, L. F.
1894. Harris, G. D., Lyman, B. S., Walcott, C. D.
1894-95. White, D.
1895. Clark, W. B., Cope, E. D.
1896. Clark, W. B., Fontaine, W. M., Marsh, O. C.
1897. Clark, W. B.

Mineralogy and Petrography.

1819. Cornelius, E.
1829. Cocke, J. H., Shepard, C. U.
1831. Hayden, H. H.
1835. Clemson, T. G.
1836. Shepard, C. U.
1842. Hubbard, O. P., Silliman, B., Rogers, W. B.
1843. Shepard, C. U.

1850. Johnson, W. R.
1854. Rogers, W. B.
1856. Rogers, W. B.
1866. Wurtz, H.
1869. Wurtz, H.
1871. Mallett, J. W.
1874. Tanner, J. A.
1874-75. Hunt, T. S.
1875. Mallett, J. W., Prime, jr., F., Wurtz, H.
1877. Brown, W. G., Koenig, G. A., Mallett, J. W.
1878. Mallett, J. W., Santos, J. R.
1880. Prime, jr., F., Rogers, W. B.
1881. Britton, J. B., Campbell, J. L., Dunnington, F. P., Heyward, B. H., Hotchkiss, J., Sloan, B. E.
1882. Baker, A. L. Campbell, J. L., Dunnington, F. P., Fontaine, W. M., Foote, A. E., Heyward, B. H., Koenig, G. A., Lewis, H. C., Lippitt, T. P., McCreath, A. S., Musgrave, R. N., Porcher, S., Rand, T. D., Seamon, W. H., Sloan, B. E., Rogers, W. B.
1883. Adams, W. H., Dunnington, F. P., Fontaine, W. M., Frazer, P., Haines, R., Hotchkiss, J., Mallett, J. W., McCreath, A. S., Musgrave, R. N., Page, W. T., Seamon, W. H., Sloan, B. E.
1884. Brown, W. G., Campbell, H. D., Fontaine, W. M., Hotchkiss, J., Kunz, G. F., Sloan, B. E.
1885. Bradbury, C. M., Cabell, J. M., Chappell, L. N., Dunnington, F. P., Hidden, W. E., Hunt, T. S., Page, C. C., Robertson, R., Rowan, G. H.
1887. Kunz, G. F., Riggs, R. B.
1888. Cowlan, G. B.
1890. Clarke, F. W., Genth, F. A., Venable, F. P.
1891. Brown, W. G., Campbell, H. D., Dunnington, F. P., Eakin, L. G., Hunt, T. S., Keyes, C. R., Kimball, J. P., Schneider, E. A., Williams, G. H.
1892. Eakin, L. G., Nitze, H. B. C., Pechin, E. C.
1893. Merrill, G. P., Williams, G. H.
1894. Goldsmith, E., Nason, F. L., Williams, G. H.
1896. Merrill, G. P., Pechin, E. C.

Economic Geology, Mines and Mining Statistics.

1809. Latrobe, B. H.
1819. Grammer, J., Kain, J. H.
1825. Robinson, S.
1834. Del Rio, A., Millington, J., Hayden, H. H.
1835. Clemson, T. G., Taylor, R. C.
1836. Hildreth, S. P.
1837. Maury, M. F., Silliman, B.
1838. Hunt, H.
1840. Taylor, S.
1841-43. Johnson, W. R.
1842. Wooldridge, A. S.
1843. Hayden, C. B.
1844. Johnson, W. R.
1852. Johnson, E. W.
1852-57. Rogers, W. B.
1853. Hitchcock, E.
1854. Whitney, J. D., Rogers, H. D.
1854-56. Rogers, W. B.
1856-59. Jackson, C. T.
1859-61. Richardson, J. W.
1862-64. Lesley, J. P.
1866. Bannan, B., Daddow, S. H., Evans, S. W., Lesley, J. P.
1867. Taylor, J. W.
1867-69. Credner, H., Lyman, B. S.
1870. Diss DeBarr, J. H.
1871. Credner, H., Mills, J. E.
1871-73. Heinrich, O. J.
1872. Imboden, J. D.
1873. Hunt, T. S., Lyman, B. S.
1874. Ansted, D. T., Goldsmith, E., Harden, J. W., Heinrich, O. J.
1875. Coryell, M., Prime, jr., F.
1876. Boyd, C. R., Heinrich, O. J., Maury, M. F., Fontaine, W. M.
1877. Frazer, P., Morton, J. H.
1878. Cresson, C. M., Morton, J. H.
1878-79. Firmstone, H.
1879. Pollard, T. P., Groddeck, A. Von.
1879-80. Boyd, C. R., Heinrich, O. J., Egleston, T.
1880. Becker, G. F., Beckwith, L. F., Bowron, W. M., Boyd,

C. E., Byrd, W., Campbell, J. L., Currey, R. O., Donald, W. A., Egleston, T., Emmons, S. F., Fink, H., Hotchkiss, J., Johnson, jr., C. F., King, C., McDonald, M., Moore, P. N., Morris, S. F., Peckham, S. F., Prime, jr., F., Pumpelly, R., Shaler, N. S., Shelley, E., Stegleman, C. M., Rogers, W. B., Weeks, J. D.

1881. Boyd, C. R., Buck, S. M., Campbell, J. L., Dewey, F. P., Donald, W. A., Drown, T. M., Egleston, T., Hotchkiss, J., Kimball, J. P., Lyman, B. S., Stevens, J. G., Stevenson, J. J.

1882. Campbell, J. L., Halsey, J. W., Hotchkiss, J., Lesley, J. P., Pollard, T., Porcher, S., Robertson, W., Rogers, W. B.

1882-83. Bowron, W. M., Fontaine, W. M., Frazer, P.

2883. Atkinson, W. G., Campbell, H. D., Campbell, J. L., Clerc, F. L., Fontaine, W. M., Hotchkiss, J., Howell, I. H., Kirchhoff, jr., C., Lathrop, W. A., McCreath, A. S., Platt, Raymond, R. W., Rogers, W. B., Smock, J. C., Williams, jr., A.

1883-84. Adams, W. H., Blake, W. P., Clarke, F. P., Day, D. T., Dewey, F. P., Martyn, W., Peale, A. C., Weeks, J. D., Williams, jr., A.

1884. Adams, W. H., Boyd, C. R., Campbell, H. D., Campbell, J. L., Chatard, T. M., Clarke, F. W., Fontaine, W. M., Froehling, H., Gifford, J. B., Gilham, W., Hotchkiss, J., Lathrop, W. A., McCreath, A. S., Robertson, W., Sheafer, P. W., Whitehead, T., Wise, F. N.

1884-85. Committee (Bramwell, J. H., Buck, S. M., Williams, E. H.).

1885. Ashburner, C. A., Benjamin, Boyd, C. R., Brock, R. A., Davis, F., Davis, H., Hotchkiss, J., Kimball, J. P., Kunz, G. F., Massie, F. A., Peale, A. C., Ruffner, W. H., Seamon, W. H., Silliman, B., Sproull, H. S., Stevenson, J. J., Swank, J. M., Weeks, J. D., Williams, jr., A., Winslow, A.

1886. Ashburner, C. A., Becker, G. F., Benjamin, M., Benton, E. R., Boyd, C. R., Chatard, T. M., Chauvenet, W. M., Day, D. T., Day, W. C., Lyman, B. S., Peale, A. C., Raborg, W. A., Rothwell, R. P., Swank, J. M., Wendt, A. F., Weeks, J. D., Vodges, A. W.

1886-87. D'Invilliers, E. V., McCreath, A. S.

1887. Ashburner, C. A., Day, D. T., Day, W. C., D'Invilliers, E. V., McCreath, A. S., Raborg, W. A., Russell, I. C., Swank, J. D., Weeks, J. D., Williams, jr., A.

1888. Ashburner, C. A., Day, D. T., Day, W. C., D'Invilliers, E. V., Hungerford, W. S., Killebrew, J. B., Kunz, G. F., McCreath, A. S., Means, E. C., Page, W. N., Peale, A. C., Proctor, J. R., Raborg, W. A., Swank, J. M., Weeks, J. D.

1889. Clarke, F. W., Chatard, T. M., Hillebrand, W. F., Killebrew, J. B., Ledoux, A. R., Newell, F. H., Pechin, E. C., Whitfield, J. E.

1889-90. Birkinbine, J., Day, D. T., Day, W. C., Kent, W., Parker, E. W., Peale, A. C., Raborg, W. A., Weeks, J. D.

1890. American Manufacturer, Ashburner, C. A., Birkinbine, J., Catlett, C., Childs, L. J., Day, D. T., Day, W. C., Emmons, S. F., Howard, E. L., Jones, J. H., Kunz, G. F., McDowell, F. H., Merrill, G. F., Middleton, J., Parker, E. W., Peale, A. C., Penrose, jr., R. A. F., Rothwell, R. P., Weeks, J. D., Whitfield, J. S., Wright, C. D.

1891. Birkinbine, J., Day, D. T., Day, W. C., Douglas, J., Hill, R. T., Jones, J. H., Parker, E. W., Pechin, E. C., Weeks, J. D.

1892. Benedict, W. DeL., Birkinbine, J., Childs, L. J., Day, D. T., Day, W. C., D'Invilliers, E. V., Edwards, W. S., Engelhardt, F. E., Hall, C. E., Holmes, J. A., Holmes, W. H., Johnson, G. R., Kunz, G. F., McCreath, A. S., Newberry, S. B., Nitze, H. B. C., Parker, E. W., Peale, A. C., Pechin, E. C., Penrose, jr., R. A. F., Phillips, W. B., Rothwell, R. P., Smith, W. A., Weeks, J. D., Yates, H. N.

1892-93, Campbell, M. R., Case, W. H., Kemp, J. F., Moxham, E. C., Peale, A. C.

1893. Adams, W. H., Birkinbine, J., Boyd, C. R., Day, D. T., Day, W. C., Fleming, H. S., Hill, R. T., Hopkins, T. C., Ingalls, W. R., Merrill, G. P., Newberry, S. B., Parker, E. W., Penrose, jr., R. A. F., Preston, R. E., Proctor, J. R., Ries, H., Rothwell, R. P., Ulke, T., Weeks, J. D.

1894. Darton, N. H., Emmons, S. F., Glenn, W., Weeks, J. D.

1894-95. Birkinbine, J., Boyd, C. R., Day, W. C., Parker, E. W., Rolker, C. M., Weeks, J. D.

1895. Tarr, R. S., Whitehead, T.

1896. Louis, H., Phillips, J. A.

Maps.

1873. Lesley, J. P.
1874. Rogers, W. B.
1875. Stevenson, J. J.
1876. Hotchkiss, J,, Rogers, W. B.
1879. Heinrich, O. J.
1880. Currey, R. O., Hotchkiss. J., Rogers, W. B.
1881. Hotchkiss, J., Lyman, B. S., Stevenson. J. J.
1882. Hotchkiss, J., Rogers, W. B.
1884. Yates, C. M.
1885. Hotchkiss, J., Lamb, R., McGee, W J.
1887. Stevenson, J. J.
1891. Boyd, C. R.
1895. Topographic Maps (U. S. Geol. Surv.).
1897. Geologic Atlas of the United States.

⁂

ERRATA.

Page 11, line 24: for Primoidal read Primordial.
“ 37, “ 5: for **Hodge, M. Jas.,** read **Hodge, Jas. M.**
“ 61, “ 7: insert paper after Nitze's.
“ 74, “ 26: for **Eakins, L. G.,** read **Eakin, L. G.**
“ 75, “ 22: for in the connection read in connection.

Vol. 2

BULLETINS
OF
AMERICAN PALEONTOLOGY

No. 8

NOTES ON EOCENE MOLLUSCA, WITH DESCRIPTIONS OF SOME NEW SPECIES

BY

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March 5, 1897

Ithaca, N. Y.
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Smithsonian Institution,
JAN 19 1910
National Museum.

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T. H. Aldrich.

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INTRODUCTION.

This brief paper contains descriptions of a number of small species which the writer has had on hand for many years and now publishes at the suggestion of G. D. Harris. Notes on allied forms, and drawings of some species not heretofore adequately figured, are added. Dr. J. C. McConnell has furnished the illustrations.

NOTES AND REMARKS ON EOCENE SPECIES.

Heilprin's Species Published in 1880.

Angelo Heilprin described in the Proceedings of the National Museum, vol. 3, 1880, a number of new forms, the types of which are now in the Museum. Through the kindness of W. H. Dall, I have been able to borrow the originals, and have had them carefully redrawn. The following notes are added by Harris and myself.

Crassatella declivis, Pl. 3, figs. 1, a.

Syn. *C. declivis* Heilp., *l. c.*, p. 151, pl., fig. 9.

This and *C. capri-cranium* Rogers are now considered to be variations of *C. alæformis* Con., Jour. Acad. Nat. Sci., vol. vi, p. 228, pl. 10, fig. 1, 1830. Length, 1¾ inches.

The typical locality for *C. declivis* is Aquia creek, Va.

"Terebra" plicifera, Pl. 3, figs. 2, a.

Syn. *T. plicifera* Heilp., *l. c.*, p. 151, pl., fig. 8.

The drawing herewith given is of one of the type specimens in the U. S. National Museum. The locality given for these specimens is Atascosa county, Texas. They are somewhat friable, and from a blue clay matrix. Casts and imprints of this species were collected by members of the Texas Geological Survey on Peeler's ranch in Atascosa county. Although the aperture cannot now be determined beyond a doubt, it certainly indicates a close relationship with the Cerites. If it proves to be a *Cerithium* then the specific name must be changed, for it is preoccupied.

Levifusus pagoda, Pl. 3, fig. 3.

Syn. *Pleurotoma pagoda* Heilp., *l. c.*, p. 149, pl., fig. 1.
Fusus pagodiformis Heilp., Proc. Acad. Nat. Sci. Phila., 1880, p. 375.
Fusus pagodæformis Heilp., *Ibid.*, 1890, p. 395.
Levifusus pagoda var., Har., Bull. Amer. Paleont., vol. i, p. 207, pl. 19, fig. 8, 1896.

The reasons given by Harris for placing this species among the *Levifusi* may be found on p. 207 as cited above. A more elaborate discussion of the subject will be given in his forthcoming Bulletin on the Lignitic Stage.

Heilprin gives simply "Eocene of Alabama" for the horizon and locality of the type, the same figured herewith. It doubtless came from a Wood's Bluff outcrop. Length, 1½ inches.

"Fusus" marnochi, Pl. 3, figs. 4, a.

Syn. *F. marnochi* Heil., *l. c.*, p. 151, pl., fig. 6.

The type specimen in the National Museum still remains unique. Its generic position is extremely doubtful. The lines of growth shown by figure 4a correspond very closely to those of *Euthria*. Dall regards it as a *Pusionella*. When more and better specimens are obtained, its generic position can be more accurately determined. Length, four-fifths inch.

Locality.—TEXAS: Atascosa county.

Scala unilineata, Pl. 3, figs. 5, a.

Syn. *Scalaria unilineata* Heil., *l. c.*, p. 150, pl., fig. 5.

Described from Jackson, Miss. His specific name is preoccupied. Length, ¾ inch.

Eucheilodon creno-carinatus, Pl. 4, fig. 1.

Syn. *E. creno-carinata* Heilp., *l. c.*, p. 150, pl., fig. 4.
E. creno-carinata var., Har., Proc. Acad. Nat. Sci. Phila., 1896, p. 471, pl. 18, fig. 9.

This species is certainly quite variable in markings and may be equal to *E. reticulata* Gabb. Length of fragment, 1 inch.

Locality.—MISSISSIPPI: Jackson.

Surcula gabbi, (eroded specimen), Pl. 4, fig. 2.

Syn. *S. gabbi* Con., Amer. Jour. Conch., vol. i, p. 142, pl. 11, fig. 5, 1865.
Pleurotoma platysoma Heilp., *l. c.*, p. 150, pl., fig. 3.
S. gabbi Har., Proc. Acad. Nat. Sci. Phila., 1895, p. 56, pl. 4, fig. 5.

The reason for regarding *platysoma* as *S. gabbi* is that in working over many specimens of *gabbi* one finds eroded specimens indistinguishable from the form shown by figure 2. Heilprin gives as locality, Atascoca county, Tex., but precisely the same thing occurs at Smithville. Length, 2 inches?

Pleurotoma venusta, Pl. 4, fig. 3.

Syn. *P. venusta* Heilp., *l. c.*, p. 150, pl., fig. 2.

Locality, Jackson, Miss. Name is preoccupied, but the form has probably been described as *Pl. perexilis* Ald. Length, 1¼ inches.

Cornulina armigera, (young var.), Pl. 4, fig. 4.

Syn. ——— ——— Heilp., *l. c.*, pl., fig. 7.

Heilprin gives no locality nor name to his figure 7, the same specimen herewith figured. Specimens in the Texas State Survey collection from Atascosa county are similarly ornamented. In Harris' MS. report on the Eocene mollusca of Texas, 1893, we read, "The fact that these young specimens are without spines on the body whorl can scarcely be regarded as sufficient reason for referring them to a distinct species. The same remark applies to their slenderer form. Specimens have already been found that are intermediate between the varietal and the typical form.

"*Localities.*—Peeler's ranch; and S. E. of Campbellton, Atascosa county, Tex."

In Harris' forthcoming Bulletin on the Lignitic Stage many marked varieties of this species will be given. In the Texan report above referred to, a varietal name for the smooth form was proposed, *viz.*, var. *heilpriniana*.

Notes on Various Forms.

Mathilda regularis Meyer, Pl. 1, figs. 1a, b, c.

This specimen was obtained on the upper part of the bluff at Vicksburg, Miss. The type came from Red Bluff, Miss. This figure is much more accurate and complete than the original.

Solariorbis subangulatus Meyer, var., Pl. 4, fig. 8.

Shell small, depressed, whorls five, rapidly increasing in size; surface covered with fine revolving lines, umbilicus deep; aperture approaching quadrate, suture distinct.

This agrees with Meyer's description and figure. If new, however, it may be called *S. liniferus*. Type was obtained at Jackson, Miss.

Locality.—ALABAMA: Choctaw Corner, Wood's Bluff horizon.

Dosinia mercenaroidea, Pl. 1, figs. 10, a.

Syn. *Dosinia mercenaroidea* Ald., Jour. Cinn. Soc. Nat. Hist., 1887, p. 82.

Heretofore unfigured.

Locality.—ALABAMA: Base of Claiborne Bluff.

Fusus ottonis.

Syn. *Fusus meyeri* Ald., *non F. meyeri* Dunker.

Name being preoccupied is herewith changed.

Pleurotoma pulcherrima, Pl. 5, fig. 7.

Syn. *Conus pulcherrimus* Heilp., Proc. Acad. Nat. Sci. Phila., 1879, p. 213, pl. 13, fig. 8.

A much more perfect specimen than the type, is here figured. There is no doubt of its being a *Pleurotoma*.

Cylichna aldrichi, Pl. 4, fig. 5.

Syn. *Bulla biumbilicata* Meyer, *non B. biumbilicata* Desh.
B. (*Haminea*) *aldrichi* Langdon, Amer. Jour. Sci., vol. xxxi, 1886.

The specimen figured came from Choctaw Corner, Ala., where it is rather common.

M. Cossmann is in error in placing this shell under *Atys oviformis* Meyer, and evidently had not seen Langdon's description when he made his observations in "Notes Complémentaires," 1893, p. 50. In his "Revue Bibliographique pour l'Année," 1895, he has also united *Cylichna meyeri* Ald. with his *C. acrotoma*. They are not the same. A letter just received from M. Cossmann places *C. meyeri* in the subgenus *Acrostemma* of *Roxania*, and his species is called *Bullinella acrotoma*.

Tuba antiquata Con., Pl. 4, fig. 7.

Figure of a young shell from Choctaw Corner, Ala.

Scala octolineata Con., Pl. 4, figs. 6, a.

These specimens are from the same vicinity where Conrad is said to have obtained his shell. It is believed to be his species.

Locality.—Alabama: "The Rocks," Clark county.

Sportella gregorioi Coss., Pl. 5, fig. 4.

This form is figured because my specimen seems to be the opposite valve from the type figure.

Locality.—Alabama: Claiborne sand bed at W. Pugh's, Clark county.

The Genus *Ringicula* in American Eocene Deposits.

Several new species have lately been added to this genus from the Eocene, and the list now contains the following, a part of which are described in this paper.

Ringicula biplicata, Pl. 2, fig. 12.

Syn. *Marginella biplicata* Lea, Cont. to Geol., p. 201, pl. 6, fig. 216, 1833.
Ringicula biplicata Con., Check list, 1866, p. 9.
R. biplicata Con., Amer. Jour. Conch., 1865, p. 35.
R. biplicata DeGreg., Annales de Geol., 8e livr., p. 167, pl. 16, figs. 26-33, 1890.
R. biplicata var. *vilma* DeGreg., *Ibid.*, figs. 26-29.
R. biplicata var. *pita* DeGreg., *Ibid.*, figs. 30-31.
R. biplicata var. *leuca* DeGreg., *Ibid.*, figs. 32-33.
R. biplicata Coss., *Ibid.*, 12e livr., p. 50, 1893.

M. Cossmann correctly considers the varieties described by De Gregorio as different periods of growth of the same species. The figure given here is copied after O. Meyer's. The type specimen in the Academy of Natural Sciences, Philadelphia, has a broken spire. Described from the Claiborne sand bed, Claiborne, Ala.

Ringicula mississippiensis, Pl. 2, fig. 13.

Syn. *R. mississippiensis* Con., Proc. Acad. Nat. Sci. Phila., 1847, p. 287.
R. mississippiensis Con., Jour. Acad. Nat. Sci. Phila., 1848, p. 117, pl. 11, fig. 36.
R. (*Ringinella*) *mississippiensis* Con., Amer. Jour. Conch., 1865, p. 35.

The figure given here is copied after O. Meyer's and has been compared with the type. Described from Vicksburg, Miss.

Ringicula trapaquara, Pl. 2, fig. 7.

Syn. *R. trapaquara* Har., Proc. Acad. Nat. Sci. Phila., 1895, p. 53, pl. 3, fig. 7.

Described from Texas.

Ringicula butleriana, Pl. 2, fig. 14.

Syn. *R. butleriana* Ald., Bull. Amer. Paleont., vol. i, p. 57, pl. 2, fig. 8, 1896.

Described from Butler, Ala. Wood's Bluff horizon.

Ringicula dalli, Pl. 2, fig. 6.

Syn. *R. dalli* Clark, J. H. Univ. Cir., vol. xv, p. 4, 1895.
R. dalli Clark, Bull. U. S. Geol. Surv., No. 141, p. 64, pl. 9, figs. 3a, 3b, 1896.

Described from Woodstock, Va. Type figured here.

Ringicula lisbonensis, n. sp., Pl. 2, fig. 11.

This Bulletin.

Ringicula alabamensis n. sp., Pl. 2, figs. 8, a.
This Bulletin.

Ringicula butleriana var. **lignitifera** n. var., Pl. 2, fig. 9.
This Bulletin.

Ringicula claibornensis n. sp., Pl. 2, fig. 10.
This Bulletin.

Descriptions of New Species.

Gastropoda.

RINGICULA.

Ringicula lisbonensis n. sp., Pl. 2, fig. 11.

Shell small; whorls five; surface marked with close-set spiral lines; aperture narrow, about half the length of the shell; outer lip smooth, terminating posteriorly on the body whorl before reaching the suture; the continuation around the posterior notch strongly developed till it reaches the centre of the inner lip; two strong plaits on the inner lip.

This little species is smaller than *R. biplicata* Lea. It has a smooth outer lip and the posterior canal to the aperture different from any other form known.

Locality.—Alabama: Lisbon.

Ringicula claibornensis n. sp., Pl. 2, fig. 10.

Shell small; whorls five; the first three nearly smooth, balance spirally striated; aperture narrow, rather long, but not reaching the suture; outer lip very strongly reflexed, smooth outside and and within; inner callus heavy, with a small erect tooth projecting from the posterior part; the anterior with two strong plaits angular to each other; anterior notch strongly developed.

This species is larger than *R. biplicata* Lea, and has no smooth band below the suture, the outer lip is smooth within, and much stouter than in the other form.

Locality.—Alabama: Claiborne sand bed, Claiborne.

Ringicula alabamensis n. sp., Pl. 2, figs. 8, a.

Shell small; spire blunt; whorls five, first two smooth, the others spirally striated; the striæ are exceedingly fine and closely set; aperture long and narrow, the border of the posterior notch reaching beyond the suture; outer lip reflexed and flattened, faintly striated anteriorly; inner callus strong posteriorly, with two moderate plaits very angular to each other.

This species is of medium size and is peculiar in having the longest aperture of any species known in our Eocene. The surface is much more finely marked than other forms. It approaches *R. trapaquara* Harris, but differs, as above stated, from it. It is much closer to *R. dalli* Clark, and while the plaits on the inner lip are more angular to each other, and the aperture a little longer, yet other specimens may be found to unite the two forms.

Locality.—ALABAMA: Matthews' Landing.

Ringicula butleriana var. **lignitifera** n. var., Pl. 2, fig. 9.

Shell medium, rather wide; inner lip striated within; callus strong, bearing posteriorly a small erect tooth, anteriorly with two strong plaits.

This form is placed here provisionally; more examples may justify its erection into a new species. None of many examples of *R. butleriana* Ald. show the striated outer lip. A single example resembling this variety was obtained at Nanafalia, Ala.

Locality.—ALABAMA: Bell's Landing (upper) bed.

PHILINE.

Philine alabamensis n. sp., Pl. 5, fig. 6.

Shell oval; whorls about one and a half, smooth and rudimentary at the apex, elsewhere covered with fine spiral lines which are finely zig-zag; outer whorl rising above the apex, constricted above, expanding rapidly below.

This is an exceedingly thin and delicate shell, the first of the genus to be found in our Eocene.

Locality.—ALABAMA: Wood's Bluff horizon at Choctaw Corner.

ACTÆON.

Actæon cossmanni n. sp., Pl. 2, fig. 5.

Shell slender; shining spire bluntly pointed; whorls seven, body whorl over half the length of the shell; suture impressed; surface ornamented with fine, close-set, impressed, spiral lines;

aperture oblong-ovate; outer lip simple; base of shell pointed and curved upwards; inner lip incurved, reflected in its anterior half, the spirals become coarser at the base of the shell and at their juction with the inner lip.

This species belongs to the section *Crenilabium* of Cossmann, and is especially distinguished from the other sections by the absence of a fold and by its pointed aperture at base.

Locality.—ALABAMA: Figured specimen from Gregg's Landing; also found in Wood's Bluff horizon at Choctaw Corner.

SCAPHANDER.

Scaphander ligniticus n. sp., Pl. 2, fig. 4.

Shell thin, cylindrical, narrowing posteriorly; outer lip rising above the shell; surface finely striated.

Differs from *S. alabamensis* Ald. in its being narrower posteriorly and longer, and from *S. primus* Ald. by its more regularly cylindrical shape. A specimen is in the National Museum, Washington.

Locality.—ALABAMA: Wood's Bluff horizon at Choctaw Corner.

CERITHIOPSIS.

This genus is represented in the Eocene by *C. nassula* Con. from the Claiborne sand bed; *C. langdoni* Ald. from Red Bluff, Miss., which form has been considered to equal the first named species. Both are *Lovenellæ*, but Conrad's species has only three tuberculated revolving lines, while the latter has five. Both shells are mature. The first named species has also been recorded from Newton, Miss. *C. aldrichi* Mr. belongs in the section *Metaxia* according to Prof. Dall. It is recorded from Red Bluff and Jackson, Miss., and Claiborne, Ala. *C. jacksonensis* Mr. is equal to *C. nassula* Con. according to Prof. Dall and seems to connect *C. langdoni* Ald. with it. *C. bicostellatum* Con. described as a *Cerithium* is a *Cerithiopsis*. It has not been figured. The following forms seem to be new.

Cerithiopsis dalli n. sp., Pl. 1, figs. 5, a.

Shell subcylindrical, ornamented with two rows of tubercles which are indented with two or three revolving impressed lines, and separated by two or three spirals, giving the whorls a constricted appearance in the centre; the tubercles are rather large; suture linear, impressed.

This form is quite distinct, but unfortunately the type and only specimen on hand has been crushed so that only a fragmentary description is possible. The large, coarse tubercles are quite peculiar and serve to distinguish the species from all others. That part of fig. 5a which shows the tubercles on a smooth surface has lost its outer layer.

Locality.—ALABAMA: Matthews' Landing.

Cerithiopsis conica n. sp., Pl. 1, fig. 4.

Shell small, slender, with four or five embryonic whorls which are longitudinally striate, the following ten whorls as in figure; sculpture consisting of three raised spirals equidistant on each whorl, crossed by numerous raised ribs which are nodular at the intersections; sutural area rather wide carrying in the bottom of the trough a smaller spiral which is nodulous; base smooth; canal short, strongly twisted.

Differs from all other forms by the peculiar corded spiral at the suture.

Localities.—ALABAMA: Baker's Bluff on Tombigbee river near St. Stephens; Claiborne sand horizon and White's marl bed, Monroe county.

Cerithiopsis fluviatilis n. sp., Pl. 1, fig. 3.

Shell small, with four or more embryonic whorls which are striated axially with fine wavy lines, followed by eight or ten whorls, these are ornamented with two raised spirals rather coarse, which are cut into nodules by the two spirals on that part of each whorl nearest the spire; bordering the base of each whorl is another spiral sometimes smooth as in figure or smooth on the body whorl and beaded strongly on the apical one, or in one example with three beaded spirals; suture strongly marked; base with two raised spirals near periphery, otherwise smooth, except almost microscopic lines of growth; canal strongly twisted.

Several specimens were found, all differing from each other in degree of ornamentation. The base of *C. nassula* appears to be smooth while this is not. The third or lower spiral line is farther from the middle one than it is from the upper one.

Looking down from the spire a beaded line appears on the lower side of the sutural area that does not appear in the side view.

Locality.—ALABAMA: Choctaw Corner.

CANCELLARIA.

Cancellaria marieana n. sp., Pl. 1, fig. 6.

Shell small, rather narrow and elongate; whorls six, rounded, three nuclear and three adult, adult whorls shouldered, cancellated; aperture ovate below, more pointed above; labrum crenulated in old specimens; pillar lip with two folds; shell umbilicated.

Rather common; differs from all others by its graceful shape and small size when adult.

Locality.—ALABAMA: Wood's Bluff horizon, Choctaw Corner.

ODONTOSTOMIA.

Odontostomia insignifica n. sp., Pl. 1, fig. 8.

Shell small, robust; surface smooth; whorls five; outer lip striate internally; inner lip with a strong plait nearly horizontal in front and expanded into a callus to base of shell.

Locality.—ALABAMA: Gregg's Landing.

VOLVARIA.

Volvaria (Volvariella) alabamensis n. sp., Pl. 2, fig. 3.

Shell small, thin, cylindrical; whorls five, three embryonic and smooth, the others covered with numerous, close-set, spiral, impressed lines; aperture long and narrow, over two-thirds the length of shell; outer lip smooth within except at the edge where the spiral lines show through; inner lip with two oblique basal folds which are continued to the end by a callus.

Only two specimens obtained.

Locality.—ALABAMA: Wood's Bluff horizon, Choctaw Corner.

CERITHIUM.

Cerithium delicatulum n. sp., Pl. 1, fig. 9.

Shell as in figure, rather slender, elongate; whorls covered with numerous, coarse, axial ribs crossed by three spiral ones, nodular at the intersections; suture deeply impressed, bounded by a row of close-set, rounded tubercles, above by a compressed, angular space which is marked by three spiral lines.

The specimen figured is quite imperfect but sufficiently characteristic to be distinguished.

Locality.—ALABAMA: Upper bed, Hatchetigbee bluff.

SCALA.

Scala exquisita n. sp., Pl. 1, figs. 7, a.

Shell elongate, umbilicate, with about ten whorls, the nuclear ones smooth, balance with fifteen elevated, recurved varices; body of whorl covered with fine spiral striæ between the varices and on the outer part of the same; the varices are pointed above, and join at the umbilicus making a rather sharp ridge, some of them continuing over into the interior of same; aperture round.

Locality.—ALABAMA: Gregg's Landing.

TUBA.

Tuba (Mathilda) leana n. sp., Pl. 1, fig. 2.

Shell small; whorls rounded, four in number, excluding spire; nucleus twisted, blunt, erect, rather large and bulbous; surface cancellated, with five or six spirals crossed with axial lines, the spirals just below suture smaller than the others; suture strongly marked; aperture rounded, smooth within; pillar lip thick, spreading slightly at base.

This shell has some resemblance to *Eglesia pulchra* Mr. from Claiborne. The drawing shows the aperture of an immature specimen. The nucleus does not lean to one side as in *Mathilda*,

Locality.—ALABAMA: Wood's Bluff horizon, Choctaw Corner.

FUSUS.

Fusus subfilosus n. sp., Pl. 2, fig. 2.

Shell as in figure; whorls eight or nine, seven adult, strongly rounded, acute at periphery; surface covered with numerous fine spirals crossed by lines of growth, some three or four spirals on base of body whorl stronger than the others; outer lip sharp; canal long, slightly twisted; inner lip smooth; aperture a little more rounded above than shown in figure.

Very rare, only one perfect specimen found.

Locality.—ALABAMA: Claiborne.

VOLUTILITHES.

Volutilithes lisbonensis n. sp., Pl. 2, figs. 1, a.

Shell as in figure; whorls eight, the first three forming the nucleus which is smooth, the periphery of remaining whorls ornamented with rather sharp spines, body whorl with eleven ribs, spaces between shining and smooth, though very fine lines of growth are present; shell shouldered above the spines and ornamented with three spiral lines, also slightly spinous, directly above the others; suture distinct; aperture nearly two-thirds the length of the shell; columella with two large plaits, with a small one between; outer lip lirate within; basal part of body whorl closely covered with fine spirals partly impressed and partly raised.

This species resembles in general outline *V. percursor* Dall, but that species has no shoulder spines and its ribs are flattened. This form is related to *V. petrosus* Con., but is much more slender, smoother, has stronger ribs and more whorls.

Locality.—ALABAMA: Lisbon bed, Alabama river.

Pelecypoda.

LUCINA.

Lucina astartiformis n. sp., Pl. 5, figs. 1, a.

Shell small, rather solid; beak pointed and small; surface with numerous concentric raised laminæ which nearly overlap at ventral margin; between the striæ are fine radiating lines from beak to margin; striæ terminating at hinge line in raised points; hinge long and narrow; anterior of shell concave along the hinge line; escutcheon smooth; cardinal teeth separated by a deep quadrangular fosset; no laterals; muscular impressions distinct; pallial line simple; posterior part of valves somewhat flattened; margin smooth.

This species is doubtfully placed in *Lucina.*

Locality.—ALABAMA: Choctaw Corner.

KELLIA.

Kellia prima n. sp., Pl. 5, figs. 3, a.

Shell small, oblong-ovate; both posterior and anterior angulated and covered with strong folds radiating from beak to margin; substance of shell thin; surface with very fine microscopic punctures; cardinal teeth erect, with deep pit between; lateral tooth small, short, curved, a triangular fosset between it and the cardinal teeth, the end of the lateral projecting beyond the hinge plate; muscular scars moderate; pallial line simple; margin smooth.

Rare. It resembles *K. eocænica* de Rainc from the Paris basin, but has a different dentition.

Locality.—ALABAMA: Choctaw Corner.

FABELLA.

Fabella oblonga n. sp., Pl. 5, figs. 2, a.

Shell small, oblong; beaks pointed, nearly central; surface smooth except for a few lines of growth; ventral margin smooth; cardinal teeth inclined, a triangular fosset between; pallial line simple; cicatrices about equal, moderate; hinge plate flattened.

Locality.—ALABAMA: Choctaw Corner.

SCINTILLA.

Scintilla clarkeana n. sp., Pl. 5, fig. 8.

Shell as in figure; nearly equilateral; surface smooth and shining; cardinal tooth erect; no laterals; pallial line simple; cicatrices slightly impressed; ligament internal.

Locality.—ALABAMA: Choctaw Corner.

LEDA.

Leda marieana n. sp., Pl. 5, fig. 5.

Shell elongate; surface smooth anteriorly, concentrically striated in middle area of surface of shell, smooth again posteriorly; umbonal ridge sharply defined.

The specimen figured is a young shell but appears to be quite distinct.

Locality.—ALABAMA: Choctaw Corner.

LEPTON.

Lepton? alabamensis n. sp., Pl. 5, fig. 9.

Shell small, thin, oval, sides nearly parallel, giving the shell a quadrangular shape; surface smooth; cicatrices moderate, slightly impressed; pallial line simple; a small cardinal tooth slightly inclined with fosset on left side of same; no laterals.

This shell resembles in form the genus *Lepton*, but having no laterals its place is only provisional.

Localities.—ALABAMA: Baker's Bluff; Claiborne sand bed.

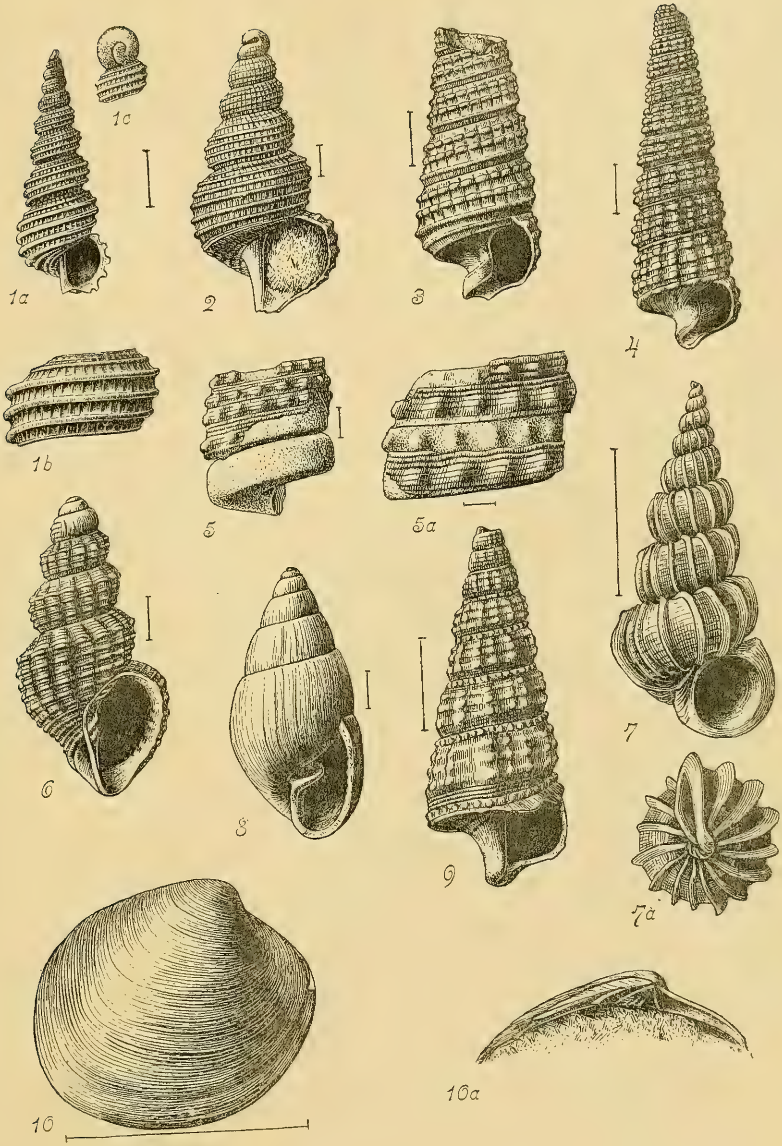
(Plate 1).

Plate 2.

EXPLANATION OF PLATE I.

(2)

Fig.		Page.
Fig. 1a.	*Mathilda regularis* Meyer	6, **172.**
b.	Showing spire.	
c.	Enlarged view of sculpture.	
2.	*Tuba (Mathilda) leana* n. sp.	14, **180.**
3.	*Cerithiopsis fluviatilis* n. sp.	12, **178.**
4.	*Cerithiopsis conica* n. sp.	“ “
5.	*Cerithiopsis dalli* n. sp.	11, **177.**
a.	“ “	
6.	*Cancellaria marieana* n. sp.	13, **179.**
7.	*Scala exquisita* n. sp.	14, **180.**
a.	Showing base.	
8.	*Odontostomia insignifica* n. sp.	13, **179.**
9.	*Cerithium delicatulum* n. sp.	“ “
10.	*Dosinia mercenaroides* Ald	6, **172.**
a.	Showing hinge.	


1a
1c
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4
1b
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5a
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7a
10
10a

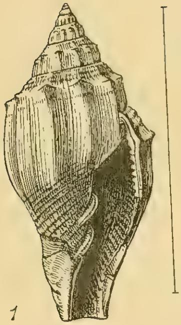
(Plate 2).

Plate 3.

EXPLANATION OF PLATE 2.

(**3**)

		Page.
Fig. 1.	*Volutilithes lisbonensis* n. sp.	14, **180.**
a.	“ “	
2.	*Fusus subfilosus* n. sp.	“ “
3.	*Volvarin* (*Volvariella*) *alabamensis* n. sp.	13, **179.**
4.	*Scaphander ligniticus* n. sp.	11, **177.**
5.	*Actæon cossmanni* n. sp.	10, **176.**
6.	*Ringicula dalli* Clark	8, **174.**
7.	*Ringicula trapaquara* Harris	“ “
8.	*Ringicula alabamensis* n. sp.	9, **175.**
a.	“ “	
9.	*Ringicula butleriana* var. *lignitifera* n. var.	10, **176.**
10.	*Ringicula claibornensis* n. sp.	9, **175.**
11.	*Ringicula lisbonensis* n. sp.	“ “
12.	*Ringicula biplicata* Lea	8, **174.**
13.	*Ringicula mississippiensis* Con.	“ “
14.	*Ringicula butleriana* Ald.	“ “



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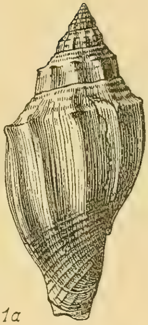

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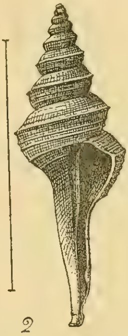

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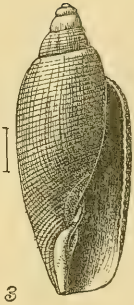

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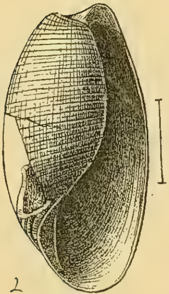

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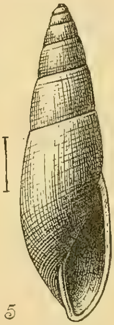

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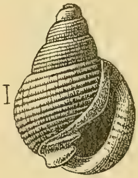

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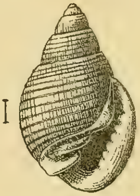

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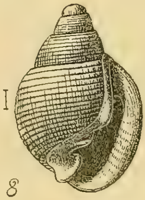

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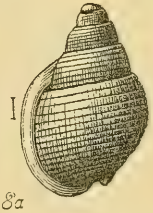

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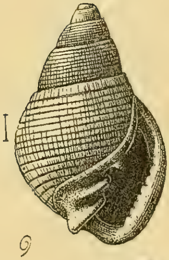

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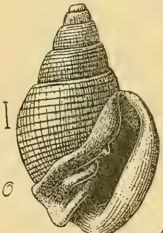

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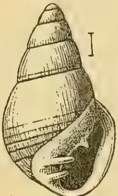

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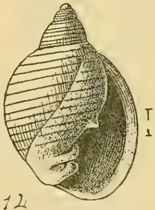

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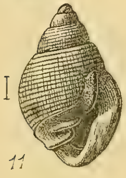

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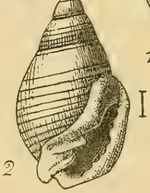

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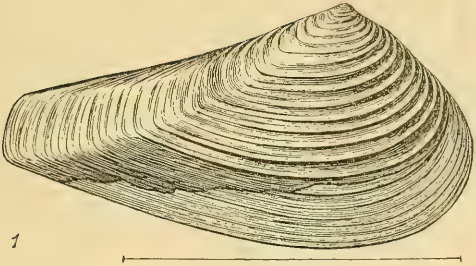
(Plate 3).

Plate 4.

EXPLANATION OF PLATE 3.

(**4**)

Fig.		Page.
Fig. 1.	*Crassatella declivis* Heilp.	4, **170.**
a.	‘‘ ‘‘	
2.	‘‘*Terebra*’’ *plicifera* Heilp.	‘‘ ‘‘
a.	Enlarged view of aperture.	
3.	*Levifusus pagoda* Harris.	‘‘ ‘‘
4.	‘‘*Fusus*’’ *marnochi* Heilp.	5, **171.**
a.	Enlarged to show lines of growth.	
5.	*Scala unilineata* Heilp.	‘‘ ‘‘
a.	Showing base.	



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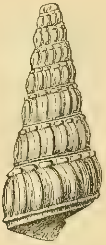

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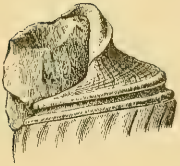

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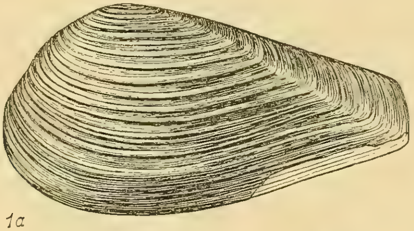

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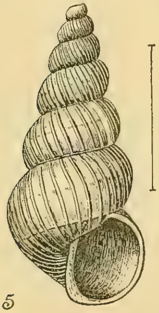

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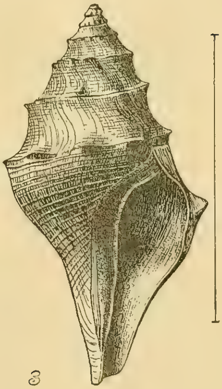

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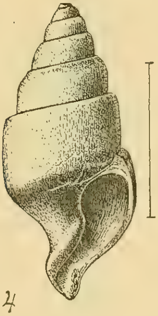

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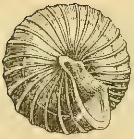

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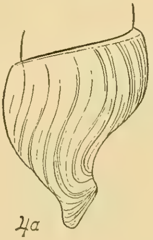

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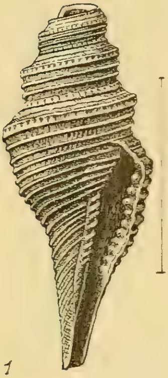
(Plate 4).

Plate 5.

EXPLANATION OF PLATE 4.

(**5**)

Fig.		Page.
Fig. 1.	*Eucheilodon creno-carinatus* Heilp.	5, **171.**
2.	*Surcula gabbi* Con. (eroded specimen)	" "
3.	*Pleurotoma venusta* Heilp.	" "
4.	*Cornulina armigera* Con. var.	6, **172.**
5.	*Cylichna aldrichi* Langdon	7, **173.**
6.	*Scala octolineata* Con.	" "
	a. Base of a second specimen.	
7.	*Tuba antiquata* Con. (young)	" "
8.	*Solariorbis subangulatus* Meyer, var.	6, **172.**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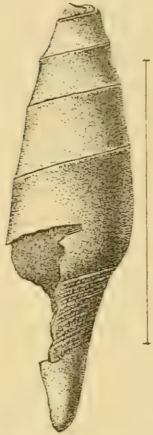
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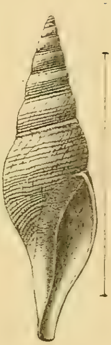
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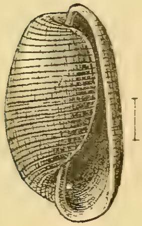
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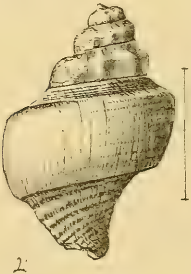
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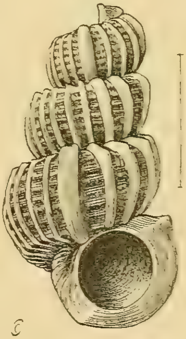
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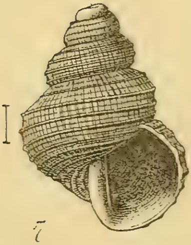
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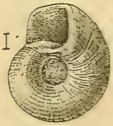
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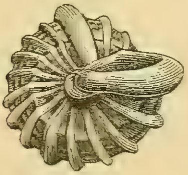
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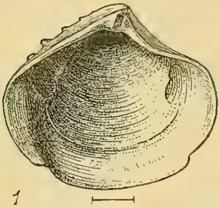
(Piate 5).
Plate 6.

EXPLANATION OF PLATE 5.

(**6**)

		Page.
Fig. 1.	*Lucina astartiformis* n. sp.	15, **181.**
a.	" "	
2.	*Fabella oblonga* n. sp.	16, **182.**
a.	" "	
3.	*Kellia prima* n. sp.	15, **181.**
a.	" "	
4.	*Sportella gregorioi* Coss.	7, **173.**
5.	*Leda marieana* n. sp.	16, **182.**
6.	*Philine alabamensis* n. sp.	10, **176.**
7.	*Pleurotoma pulcherrima* Heilp.	7, **173.**
8.	*Scintilla clarkeana* n. sp.	16, **182.**
9.	*Lepton? alabamensis* n. sp.	" "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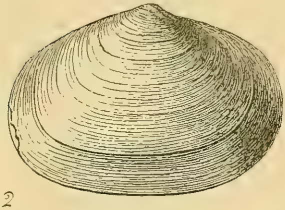
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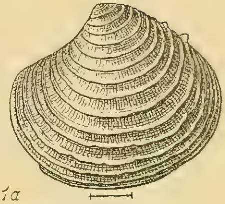
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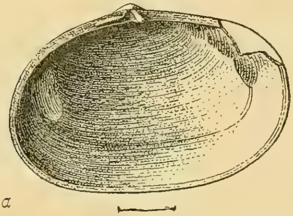
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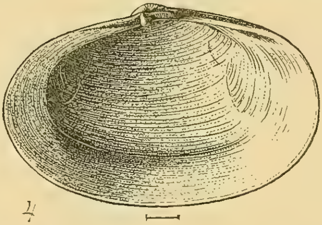
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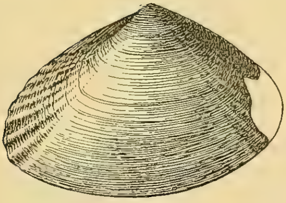
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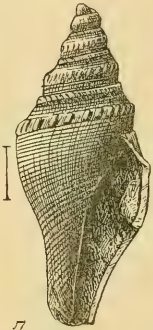
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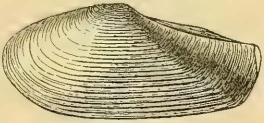
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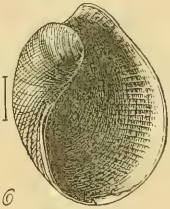
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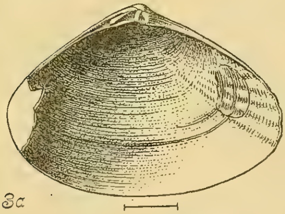
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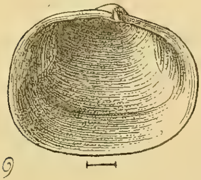
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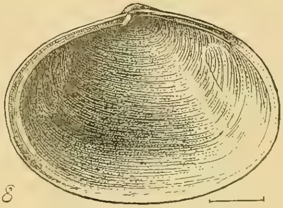
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Vol. 2

BULLETINS
OF
AMERICAN PALEONTOLOGY

No. 9

THE LIGNITIC STAGE

PART I

STRATIGRAPHY AND PELECYPODA

BY

G. D. HARRIS

June 15, 1897

Ithaca, N. Y.
U. S. A.

sonian Institution
AN 19 1910
National Museum

THE LIGNITIC STAGE.

BY

Gilbert D. Harris.

PART I.

STRATIGRAPY and PALEONTOLOGY (PELECYPODA.)

SUMMARY OF CONTENTS.

PRELIMINARY CONSIDERATIONS.

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Preliminary Considerations.

Divisions of the Lignitic.

The larger subdivisions or stages of the Eocene series have already been given on page 118, vol. 1, Bull. Amer. Paleont. The second of these stages, the Lignitic, may be conveniently subdivided as follows:

Lignitic.	Bashi.	Hatchetigbee. Woods Bluff.
	Bell's Landing.	Bell's and Gregg's Landings. Nanafalia.

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* * * * *

Aim and scope of this work.

Bulletin No. 4 was devoted to the statigraphy and paleontology of the lowest or Midway stage of the Eocene as developed in the Mississippi basin. This bulletin treats of the Lignitic as developed in the same basin. Time, however, has prevented a discussion of the univalves in this part of the work, but they will be taken up at once with the resumption of laboratory work in the fall.

Little need here be said regarding the general aim and purpose of this work, for it is a continuation of Bulletin No. 4. (See Bull. Am. Pal., vol. 1, p. 119.)

Collections of fossils, field notes, etc., on which this work is based.

The Cornell University Expedition of 1895.—A brief account of this expedition was given in Bull. 4, p. 5, and it remains here only to say that while the Midway stage was the special subject of study during 1895, frequent detours were made into nearby Cretaceous as well as Lignitic or even higher beds. The following fossiliferous Lignitic outcrops were visited : Nanafalia, Tuscahoma and Woods bluff on the Tombigbee and Ft. Gaines on the Chattahoochee.

The Cornell University Expedition of 1896.—In the spring of this year the Trustees of Cornell University generously repeated the appropriation of 1895, thus enabling Mr. W. S. Hubbard and the writer to again visit the Gulf and Atlantic States. The Lignitic outcrops of note in Alabama were examined from the Tombigbee on the west, to near Ft. Gaines on the east. The Midway beds at Black bluff were examined, and the line of nonconformability between the Cretaceous and basal Eocene not far south of Moscow Ferry was thoroughly explored. The well known *Enclimatoceras ulrichi* and *Ostrea pulaskensis* were found here as elsewhere just above the nonconformability. Better fossils were moreover obtained from a bluff opposite to and about ⅓ mile below Matthew's Landing on the Alabama. More perfect specimens of several species described from Clayton were also obtained.

Detours were made to the south of the Lignitic belt, including one as far as Jackson on the Tombigbee and Claiborne on the Alabama. Midway beds were traced to near Putnam, Ga., and the extensive northern overlapping of the Vicksburg throughout that State was noted. (See Am. Geol., vol. 18, p. 236.) A large collection was made from the classical old Shell bluff on the Savannah. Later on, in the latter part of August, collections were made from Eocene and Miocene exposures along James, Rappahannock and Potomac rivers in Virginia and Maryland, a region that will be thoroughly investigated during the present summer.

T. H. Aldrich's collection of fossils and drawings.— Mr. Aldrich has very kindly lent the greater part of his type collection of Lignitic mollusca for inspection during the preparation of this work. These as well as the drawings used in Bulletin 8 have been of great service.

The author's works and field notes on this stage in Arkansas and Alabama. — Many detailed sections of Lignitic exposures in Arkansas are given by the author in vol. 2, of the annual report of the Geological Survey of that State for 1892 ; but no zoogene fossils were found. In 1893-94 he twice visited some of the famous Alabama exposures, once while in the employ of the State Survey of Texas and once while in quest of fossils for his own cabinet. These together with his English and Paris basin fossils have been very serviceable during the preparation of this work.

SECTION I. STRATIGRAPHY.

Texas.

References :— First Ann'l. Rept. Geol. Survey Tex., 1889, p. 22, et seq.,—Penrose. Geological Survey of Texas, Report on the Brown Coal and Lignite of Texas, 1892, p. 130 et seq.,—Dumble. 2d Ann'l. Rept. Geol. Sur. Tex., 1891, p. 50 et seq.,—Kennedy.

But little is definitely known regarding the Lignitic beds of Texas. Penrose was the first to study them with any degree of care. Owing however to the lack of molluscuous remains throughout nearly their whole extent, it is impossible to accurately define them geographically or stratigraphically. Below is a brief summary of our present knowledge on the subject.

Rio Grande.—It is possible that beds belonging to the Lignitic stage will be found along the Rio Grande ; but at present there is no proof that such beds exist; on the contrary, if the expansion of the Lower Claiborne in this part of the State is, as it would seem to be from the meagre data we have, it is quite probable that it overlaps the Lignitic and Midway stages and meets the Cretaceous.

Colorado River. — On this river the Lignitic beds must be very poorly represented, for Penrose writes that five miles by river below the outcrops of the Basal clays in the neighborhood of Webberville, a low fossiliferous bluff is seen. These fossils identified by the present writer, are of Lower Claiborne horizon. Hence the Lignitic deposits can have on this river a width of no more than five miles.

Brazos River. — It is on the Brazos River where the Lignitic stage is typically exhibited. Penrose thus describes this section: *

"About a mile and a half below Pond creek is seen an outcrop of Tertiary sand, containing black specks and rendered plastic by a white clay. It is capped by semi-indurated Quaternary gravel and sand, and contains large nodules which give a strong reaction for carbonate of lime, and which are simply hardened masses of the enveloping sand. They are one to eight feet in diameter, hard, kidney-shaped, flat or nodular, and project out of the compact sandy bluff in a most characteristic manner. Loose fragments of silicified wood, which have also doubtless been derived from the same bed, lie among the many nodules that have been eroded out. So many of these rocky masses have been loosened from the sand and piled up in the bed of the river that they have obstructed its course, and have formed rapids. Many of these rocks are round or oval, and are locally known as "kettle bottoms." Such strata as these are seen down the river for a mile and a half from this point, where they dip under a series of gray clays containing beds of lignite, varying from one to five feet thick and associated with ferruginous sand. The clay contains large masses of silicified wood, which is sometimes seen in places in the bed, but more often has been weathered out and lies in the bed of the stream. Occasionally nodules of clay ironstone, generally in a semi-oxidized condition, are found. Such strata are exposed for about a mile, when the gray sands with calcareous concretions and indurations again appear. This deposit contains considerable quantities of iron pyrites, and the indurations are often cut by veins of crystalline calcite. A short distance below here is Calvert Bluff,* Robertson county, where lignite occurs in large quantities and has been worked intermittently for many years. The beds of this strata are shown in the following section:

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* 1st Ann'l. Rept. Geol. Sur. Tex., 1890, p. 26.

1.	Brown and red river silt	10 feet
2.	Gray clay	0 to 3 feet
3.	Lignite	12 feet
4.	Gray clay	2 feet
5.	Lignite	2 feet
6.	Gray clay	3 feet

The clay beds in the above section contain large clay ironstone concretions, which enclose many leaf impressions. The lignite is black, woody, friable, and of a dull lustre. It is faulted and much jointed. Dip, three degrees southeast. From here to where the International and Great Northern Railroad crosses the river we see sand beds with calcareous indurations, such as have been described at Rocky Rapids. At this point is a bluff showing sixteen feet of Tertiary strata, capped by over fifteen feet of a highly calcareous light green and yellow Quaternary clay containing many small white concretions. The base of the Tertiary part of this bluff is composed of black clay from the water edge up to ten feet above it, and is overlaid by six feet of non-fossiliferous greensand marl. The Quaternary lies unconformably on the Tertiary strata. It is to be seen at many points along the river from Falls county down, and is doubtless the representative of an old river silt formation. For twelve miles below this point is seen a series of interbedded and interlaminated clays and sands, with occasional beds of lignite, and some few small gray calcareous concretions. Frequently small fragments of lignite are seen in the sand beds, showing that the swifter waters, which changed the character of the bed from clay to sand, were also responsible for the destruction of lignite beds, the fragments of which were deposited with the sand.

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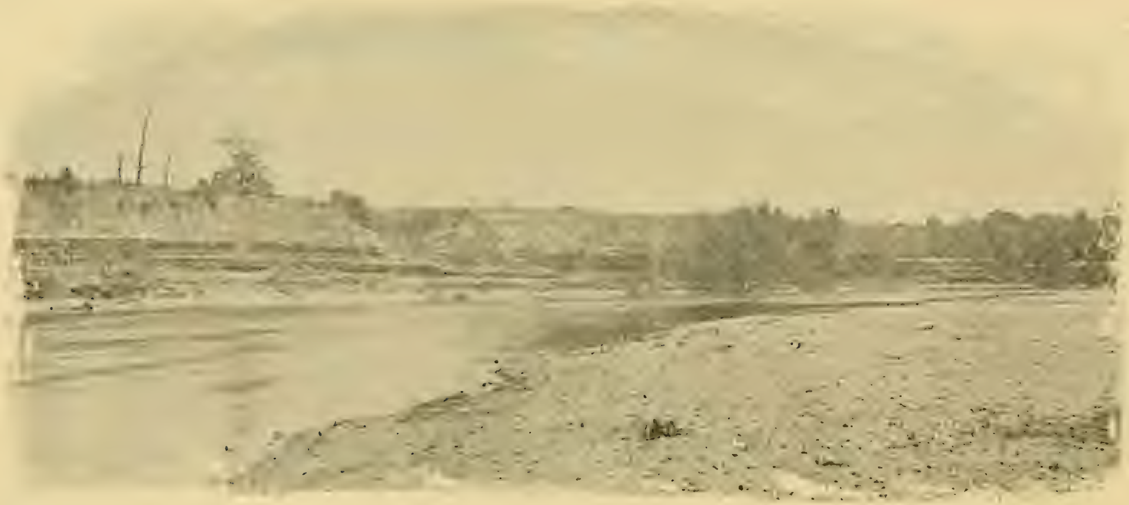
* The figure herewith given is from State Geologist Dumble's work on the Lignite or Brown Coal of Texas.



CALVERT BLUFF; a Lignitic outcrop on Brazos river, Tex.

East of Brazos River.— Lignite deposits are known to increase rapidly in areal extent eastward from the Brazos, but so far as we are aware there are no sections better adapted for study than the one just cited along that river. One thing, however, seems very remarkable, viz, the occurence of fossils on the Sabine river so far down as Sabinetown, that have a lignitic aspect. They were obtained by C. W. Johnson, while collecting for the Lea Memorial Collection. It is certainly strange that in counties to the north, as Cherokee, Rusk and Nacogdoches, in Texas and Bossier and Bienville parishes in Louisiana, typical Lower Claiborne fossils should be found in abundance, while at Sabinetown, this seemingly Lignitic fauna occurs. This is the first Lignitic fauna discovered west of Alabama.

That Lower Claiborne deposits also occur near or at this bluff, is proven by the fossils received by the Geological Survey of Texas, while the writer was one of its employés. They were furnished by Mr. John W. Low, who resides in a neighboring town, and consist of *Venericardia planicosta*, *Levifusus trabeatus*, *Nassa scalata*, *and Pseudoliva vetusta ; Nassa scalata* is so far as known confined to the Lower Claiborne.

There seem to be no grounds whatever for regarding this bluff as of Jackson or " Mansfield " age.

Mr. Johnson has very kindly furnished me with the section at Sabinetown given below. The bluff he estimated to be about 200 feet in length, and to show a southern dip of about 20 feet. He remarks " I got the fossils from the upper portion, where the bluff was not over 35 or 40 feet high. A large spring was pouring over the bank, which probably prevented the fossiliferous strata from becoming sandstone, as it was on the dry portion of the bluff. They were not very plentiful, and it was hard work to find the few I got. I was told that just above the ferry, (probably a half mile above the bluff) was a bed of lignite etc."

Section at Sabinetown, Texas.

1.	Soil	5 feet
2.	Sand, stratified and more or less indurate	25 feet
3.	Laminated sandy clay	12 feet
4.	Yellowish sand with thin layers of iron-stone	3 feet
5.	Grayish sand	7 feet

6.	Hard, fossiliferous sand-stone	3 feet
7.	Indurate sandy clay, fossiliferous	5 feet
8.	Indurate greenish sand, containing one or two strata of sandstone	20 feet
	Total	80 feet

The most characteristic species are: *Calyptraphorus trinodiferus*, *Cornulina armigera*, *Volutilithes petrosus* var. *tuomeyi*, *Corbula*, probably a var. of *alabamiensis*, *Leda aldrichiana*, *Mactra* var. *bistriata*, *Sigaretus bilix*, "*Kellia*" *prima*, *Natica*, *Tellina*, and a large *Cardium* not yet described.

Louisiana.

References: — *Report on the Iron Ore Region of La., and Eastern Texas, House Doc. No. 195, 50th Congress, 1st Ses. 1888,—Johnson. Ann'l Rept. Ark. Geol. Sur. 1892, vol. ii, p. 181,—Harris. American Geologist, vol. 15, p. 209, 1895,—Vaughan. Bull. 142, U. S. Geol. Sur. p. 15, 1896,—Vaughan.*

The northwestern corner of this State may be occupied by Lignitic deposits as indicated on the map accompanying my report on the Tertiary Geology of Southern Arkansas; vol. ii as given in the references. All molluscan remains of the Lower Claiborne stage seem to die out a few miles north of Plaindealing. These unfossiliferous beds were supposed by me to be the continuation of similar deposits in Arkansas, which I referred to the Lignitic.

Arkansas.

References: — *Trans. Amer. Philos. Soc., vol. i, New Ser. 1817, —Maclure. Jour. Acad. Nat. Sci., vol. ii, pp. 45–46,—Nuttall. Carte Géologique des États-unis et des Provinces Anglaises de l' Amérique du nord, 1858,—Marcou. Second Rept. Geol. Reconn. Ark., 1860,—Owen. Jour. Acad. Nat. Sci. 2nd Ser., vol. 9, pl 4,—Heilprin. Ann'l Rept. Geol. Sur. Ark., 1888, vol. ii,—Hill. Ann'l Rept. Geol. Sur. Ark., 1892, vol. i, pp. 105–138,—Penrose. Ann'l Rept. Geol. Sur. Ark., 1892, vol. ii,—Harris.*

In my report on the Tertiary of Arkansas, I have referred the greater portion of Grant, Dallas, Ouachita, Nevada, Columbia and Miller counties to the Lignitic stage. This I was induced to do by the presence in many places along the Cretaceous border of thin Midway deposits, and the presence of Lower Claiborne fossils in the northern Bossier, Webster, and Claiborne parishes in Louisana, and at Walnut bluff, Ouachita county, Arkansas. Farther east, in Cleveland and Jefferson counties, the Jackson with possibly some Claiborne beds approaches rapidly the Cretaceous border. It was pointed out that although beds of Lignitic age do exist in Arkansas, between these Midway and Claibornian deposits, exact lines of demarcation cannot be drawn. A general idea of their distribution is indicated by the map accompanying that report. Some of the typical localities on or near the Ouachita were described in Ann'l. Rep't. Geol. Sur. Ark., 1892, vol. ii. The old coal mine spoken of by Owen, on section 12, 12E, 18W, was visited and the following facts noted:

Mr. Richmond Hibbard who resides at that place says it is in the northeast quarter of the above section. The following outcrop is at present visible:

Section at the old mine of the Camden coal company, Ouachita county, Arkansas.

1.	Arenaceous material, not well exposed..........	
2.	Light pinkish clay..........	6 feet
3.	White sand..........	6 feet
4.	Bluish clay..........	8 feet
5.	Lignite..........	6 feet

The bed of lignite here represented is unbroken by sand or clay partings, but vertical joints passing in a north-northwest, and south-southeast direction, stained with iron oxide are numerous. Its color is more nearly that of true coal than that of any other lignitic deposit seen by the writer in the State. It is generally dull black, though streaks from one quarter to three quarters of an inch thick, of hard shiny matter are not uncommon.

There is a new opening into this bed, in 12S., 18W., section 14, the northwest quarter of the southeast quarter, which is, according to Mr. Hibbard, very nearly or quite on a level with the old opening. Other outcrops of this bed are said to occur in sections 2, 11 and 13.

The only fossils found in this vicinity by the writer were leaves, or their impressions, in a sandy, indurated, and highly ferruginated matrix. Numerous chunks taken from the new opening were literally packed with scaly, leaf-bearing layers.

The surface of this district is rendered exceedingly rough by the obdurate character of numerous sandstone beds which are underlaid by more yielding clays and sands. The absence of Orange sand is noteworthy.

The same general group of deposits doubtless obtains in 12S., 18W., section 30, where as stated above, Owen found "Tertiary" sandstone and shales, associated with the lignitic bed.*

Geology about Camden.—The vicinity of Camden is extremely interesting from a geological point of view, in that it furnishes the most extensive outcroppings of the Lignitic stage known in Arkansas. On account of these extensive and typical exposures, Hill has given the name "Camden series" to all the deposits recognized by him in southwestern Arkansas, as belonging to the Tertiary system. †

The most striking feature regarding these outcrops is the preponderance of arenaceous material. To be sure there is more or less agillaceous matter scattered through nearly all the beds, and to this constituent doubtless the permanence and perpendicularity of many of the bluffs are due ; but the few purely clay beds are compartively insignificant and grade out laterally into almost pure sand. Lignitic matter is often present to such an extent as to give the surface of an outcrop a dark gray color, but this material will generally be found upon close examination to be finely comminuted and mixed with a much greater amount of white fine qurtz sand. This peculiar feature is remarkably pronounced all along the ravine in the south central part of the town, crossed by both the St. Louis Southwestern and the Camden Division of the St. Louis, Iron Mountain and Southern Railways. Both above and below the lower terminus of this ravine there are high bluffs along the right bank of the Ouachita which are difficult of ascent, and often perpendicular. This is especially true of those just below where they rise about 70 feet above the river at a mean stage.

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* See Rep. of Geological Reconnoissance of Arkansas, 1860, p. 230.

† Annual Report of the Geological Survey of Arkansas for 1888, vol. II, pp. 50–188.

These will suffice to show the general nature and characteristics of the Lignitic beds of Arkansas.

Missouri.

We have little or no definite knowledge regarding the Tertiary of Missouri, though the lowlands of the southeastern portion are supposed to be underlaid by beds of this and perhaps the Cretaceous age. We are gratified to know that the present State Geologist is about to take this matter in hand, and it is to be hoped that this portion of the State will soon be mapped and its fossil faunas made known.

Illinois.

References : — *Geological Survey of Illinois, vol. i, p. 44 et al., 1866,* — *Worthen. Geological Survey of Kentucky, Report on Jackson's Purchase Region, 1888, pp. 45–46,* — *Loughridge.*

We have not personally visited the Tertiary deposits of this State and cannot say to what stage they belong, but it is reasonable to suppose that they should be classed as Midway or Lignitic or probably as both. The siliceous gravels and conglomerates remind one strikingly of those found in southwestern Arkansas. Worthen says : "This system [Tertiary] has only been identified in the southern portion of the State, and appears to attain its greatest development in Pulaski county, where it is represented by a series of stratified sands and clays of various colors, with beds of siliceous gravel, often cemented into a ferruginous conglomerate by the infiltration of a hydroxyd of iron. A marked feature of this system, in Pulaski county, is the presence of a bed of *green marly sand*, which from its lithological characters was at first supposed to be the equivalent of the Cretaceous green sand of New Jersey. An examination of the fossils which it affords, however, seems to leave no doubt of its Tertiary age. They consist of marine shells, belonging to the genus *Cucullæa* and *Turritella*, in the form of casts, the shell itself having been dissolved and entirely removed, so as to perclude the possibility of specific identification. A single shark's tooth was obtained from this bed near Caledonia. Along the edge of the Ohio, at Caledonia, there is a thin bed of *lignite* to be seen, at extreme low water. It is only a few inches thick, and forms the lowest stratum of Tertiary exposed in the vicinity.

"At Ft: Massac, on the Ohio, just above Metropolis, the ferruginous conglomerate already mentioned is from forty to fifty feet in thickness. * * * Siliceous wood, in a fine state of preservation has been found quite abundant in the Tertiary beds in Pulaski and Alexander counties."

Loughridge gives the Caledonia section as follows:

1.	Brown loam	10 feet
2.	Silt or loam	10 feet
3.	Gravel	5 feet
4.	Dark sandy clay, indurated	20 feet
5.	Dark joint clay, weathering into a gray shale and with cracks running S. 20° W.	25 feet
6.	Greensand (glauconite) with hyaline sand; also some black sand and clay	2 to 4 feet

The lower moiety of this bluff is undoubtedly Eocene Tertiary, but as remarked before its exact horizon is unknown.

Kentucky.

References: — *Geol. Surv. Ky., vol. i, pp. 21–24, 1856, — Owen. Am. Jr. Sci., 2nd ser., vol. 27, 364, 1859, — Lesquereux. Proc. Ac. Nat. Sci. Phila., 1886, p. 57, — Heilprin. Geol. Surv. Ky., Jackson's Purchase Region, pp. 41–52, 1888, — Loughridge.*

Some of the bluffs along the Mississippi river, presumably referable to the Lignitic stage of the Eocene were visited by D. D. Owen as early as 1854, and described by him in 1856 as "Quaternary beds" "quaternary lignite" etc. In 1859 Lesquereux identified the following species from the "chalky banks of the Mississippi River near Columbus, Ky:"

Quercus virens Michx., *Castanea nana?* Muhl., *Ulmus alata?* Michx., *Planera gmelini* Michx., *Prinos integrifolia* Ell., *Ceanothus americanus?* Lin., *Carya olivæformis* Nutt., *Gleditschia triacanthos* L., and *Acorus calamus.*

In 1888 Loughridge describes other fossiliferous outcrops which may belong to the Lignitic stage, as follows :

"On the road leading south from Paducah, and at points there and four miles distant, fine exposures are traced in the deep washes by the side of the road.

"There is a broad valley on the south of Eden's hill and on rising from this valley, going southward, the most northern of these outcrops is seen. The next exposure is about one mile farther south, or on the south side of this hill, consisting of twelve feet (exposed) of lignitic joint clay, below four feet of micaceous sand-rock, in which are large numbers of casts of Lower Eocene fossils ; about thirty feet of Quaternary gravel and loam overlie the bed. The strata seem to dip slightly to the north.

"The laminated sand-rock is again exposed a mile south, on the eastern edge of the hill of hard Onondaga quartzite at Mr. Byer's ; its outcrop is about fifty feet thick ; the strata are in an almost vertical position, and have a north and south strike. It is in the bed of the creek, and may have fallen in at some time by the undermining action of water, though it is not broken up and its bedding is very regular. Casts of fossil shells were also found here. Its surface is about five feet below that of the outcrops on the north side of the valley, in the section just described. On the west side of the hill of quartzite, and but a short distance from this sand-rock, a well, when dug, struck blackish joint clay at about fifteen feet, and penetrated it for thirty-five or forty feet without passing through it." * * *

Fossil casts found here have been determined by Prof. Heilprin, of the Philadelphia Academy of Science, to comprise the following :

"*Mysia.* — species probably *M. ungulina.*
Leda. — species probably *L. protexta.*
Leda — species indet.
Nucula. — species probably *N. ovula.*
Turritella. — species *Turritella mortoni.*"

—*Heilpin.*

Loughridge establishes a basal Eocene stage in Kentucky under the name of "Hickman group;" which represents to some extent the northern extension of the Midway of Mississippi and Tennessee. The above quotations are taken from what he terms the "Lignitic group," concerning which he makes the following general statement: "This, the next lowest division of the Eocene, embraces the two groups of Safford's Tennessee, viz: Porter's creek and bluff lignite, which he supposed were separated by his Lagrange beds, but which are in reality one and the same bed, as shown in the bluff of the Ohio on the Illinois shore at Caledonia, as well as by the continuity of the belt on the east, north and west of the Purchase region."

By consulting Bulletin Amer. Paleont. vol. i, p. 136 it will be seen that the Porter's creek group is for the most part Midway.

Tennessee.

References:—Amer. Jr. Sci., 2d ser., vol. 27, 363–365, '59, —Lesquereux. Amer. Jr. Sci., 2d ser., vol. 37, pp. 368–370, '64,—Safford. Geology of Tennessee, 1869.—Safford. Ann'l Rep't Geol. Surv. Arkansas, '89, vol. 2, p. 28, '91,—Call. Bull. State Board of Health (Tenn.) vol. v, No. 7, pp. 98–106, '90,—Safford.

The first important article on the Neozoic of Tennessee was by James M. Safford, entitled "On the Cretaceous and superior formations of West Tennessee." In his generalized section of these beds the terms he used to designate the different Tertiary formations are as follows:

"6. Bluff Lignite, (provisional), Tertiary?
5. Orange sand or LaGrange Group, Tertiary.
4. Porter's Creek Group, (provisional), Tertiary?"

He then very correctly correlates this Porter's creek group with the "Flatwoods" region of northern Mississippi, i.e. the upper part of the Midway stage as now understood. Of his LaGrange group he says: It occupies a belt about forty miles wide, which runs in a north north-easterly direction through nearly the central portion of this division of the State. As seen in bluffs, railroad cuts, gullies, and in nearly all exposures, it is generally a great stratified mass of yellow, orange, red or brown and white sands, presenting occasionally an inter-stratified bed of white, gray, or varigated clay. * * * It is difficult to estimate the thickness of the group. It doubtless dips, though at a slight angle, to the west. Its thickness may be assumed to be about 600 feet.

Three miles north of Somerville he collected a series of fossil leaves beautifully preserved in a thin sandstone in place. These were named or described by Lesquereux in the American Journal of Science 2d ser., vol. 27, p. 363, 1859, as follows:

1. *Quercus myrtifolia* Willd.; 2. *Prunus caroliniana* Michx.; 3. *Laurus carolinensis?* Michx.; 4. *Fagus ferruginea* Michx. (fruit); 5. *Quercus crassinervis?* Ung.; 6. *Quercus saffordi* Lesqx.; 7. *Andromeda vaccinifoliæ affinis*; 8. *Andromeda dubia* Lesqx.; 9. *Elæagnus inæqualis* Lesqx.; 10. *Sapotacites americanus* Lesqx.*; 11. *Salix densinervis* Lesqx. Though Lesquereux supposes these beds to be of Upper Miocene age, Safford very properly classes them as Eocene.

Of the "Bluff lignite" Safford remarks that it is but a "provisional group" generally well exposed below the gravel of the Mississippi bluffs, but may thin out in an easterly direction. He gives a section of those beds at Randolph, Tipton county, in which lignitic sandy beds are 190 feet in thickness.

Lesquereux's new species and a few others are figured in Safford's Geology of Tennessee, 7; and the general statements regarding the Neozoic of western Tennessee as referred to are reiterated in this State report.

So far as we are aware no molluscan fossils have been found in this State from the La Grange or Bluff sands—deposits that presumably belong to the Lignitic stage.

Mississippi.

References:—Amer. Jour. Sci., vol. i, p. 324, 1819,—Cornelius. Prelim. Rept. Geol. Agr. Miss., 1857,—Harper. Rept. on Geol. and Agr. Miss., 1810,—Hilgard. Proc. Amer. Asso. Adv. Sci., vol. xx, 1871, p. 222, maps,—Hilgard. Amer. Jour. Sci.. vol. iii p. 271, 187,1—Hilgard. Amer. Jour. Sci., vol. 22, pp.

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* This species is added to Lesquereux's list as published by Safford, 1864.

58–65,'88,—Hilgard. Contrib. Geol. and Paleont. U. S., p. 32, '84,—Heilprin.

Contrary to the prevailing ideas heretofore expressed, we believe the truly Lignitic deposits, i. e. those representing the Lignitic as we define them in Alabama, are not extensively developed in Mississippi save perhaps in the northern counties where they presumably represent the southern extension of Safford's La Grange group, and perhaps Bluff sand. Bordering the Cretaceous on the east are the Flatwoods clays representing doutless the Midway. On the west or southwest there is a fossiliferous Lower Claiborne horizon as indicated to some extent on Hilgard's map accompanying his report on the Agriculture and Geology of Mississippi. The "outlier" of this latter horizon about Vaiden is doubtless simply a fossiliferous phase of the same and should be connected with the Lower Claiborne to the southeast, thus embracing a considerable of the so-called "Northern Lignitic" area in the Lower Claiborne. So far as we are aware no molluscan fossils have been found in the Lignitic of this State; that the fossils at Vaiden are of Lower Claiborne age there can be no doubt for we have made satisfactory collections from that locality.

Hilgard in 1871 subdivided his Lignitic into Flatwoods and La Grange beds, and gave them the total thickness of 450 feet. From our observations in Tennessee, Mississippi and Alabama it would seem that 200 feet would not be an unreasonable estimate for the Midway (Flatwoods) beds of this State, leaving therefore 290 of La Grange deposits.

Heilprin has suggested an extension overlapping in this "Northern Lignitic" of Jackson beds, including the Vaiden fossiliferous deposits. In this he is wrong, for the Jackson beds as they passed northward would pass west of Vaiden, through the Yazoo-Mississippi flats where they have long since been carried away. The Arkansas limb of the northern extension of the Jackson is in a better state of preservation.

Alabama.

References:— Trans. Amer. Philos. Soc., vol. 6, 1st ser. p. 411, 1809,—Maclure. Trans. Amer. Philos. Soc., vol. i, 2d ser., 1817,—Maclure. Jour. Acad. Nat.

Sci., Phila. vol. 6, '28, — Vanuxem. Amer. Jour. Sci. 2d ser., vol. 6, p. 354, '48,—Hale. First Biennial Report on the Geology of Alabama, '50,—Tuomey. Proc. Ac. Nat. Sci. Phila., p. 449, '53,—Conrad; p. 166, '57,—Conrad; '64, p. 212,—Conrad. Proc. Amer. Ass. Adv. Sci., vol. x, p. 82, '57,—Winchell. Second Biennial Report on the Geology of Alabama, '58,—Tuomey. Jour. Acad. Nat. Sci. Phila., vol. 4, p. 291, 1860, —Conrad. Amer. Jour. Conch. vol. i, p. 259, '65, —Whitfield. Contr. Geol. and Pal. U. S., '84, —Heilprin. Proc. Acad. Nat. Sci. Phila., '80, pp. 364–375,—Heilprin; '81, p. 151,—Heilprin. Bull. 43 U. S. Geol. Surv., '87,—Smith & Johnson. Bull. 1, Geol. Surv. Ala., '86, —Adrich. Bull. Geol. Soc. Amer., vol. ii, p. 587, '91,—Langdon. Geol. Surv. Ala., '95, — Smith, Aldrich, Langdon. Amer. Jour. Sci., vol. 47, p. 301, '94,—Harris. Dana's Manual Geol., p. 888, '95,—Harris. Bull. Amer. Pal. No. 2, '95,—Aldrich. Bull. Amer. Pal., No. 8, '97,—Aldrich. Bull. Amer. Pal., No. 4, '97,—Harris. Proc. Acad. Nat. Sci. Phila., '96, p. 470,—Harris.

Historical notes. — This is, and ever will be, the classic or type State for the marine Eocene series in America, and it is especially true of the stage now under consideration, for while beds presumably representing this stage in Texas, Arkansas, Mississippi and other States are well developed and present some interesting features, they are nearly or wholly destitute of molluscan fossils, a want that renders their age and boundaries vague or ill defined. It seems then worth while to pause and study the development of Lignitic stratigraphy and paleontology under this heading.

Passing at once over the vague generalities of Maclure and the somwhat reformed classification of Neozoic terranes by Vanuxem, the first account of a personal observer in the Lignitic deposits of this State is that of C. S. Hale, 1848. He attempted the establishment of a generalized section of the Eocene of this State as follows:

8 & 9. White limestone.
7. Sand and shells.
6. Clay bed with oysters.
5. Marly arenaceous limestone.
4. Clay bed with oysters.
3. Sand and shells.
2. Lignite
1. (or lowest) Clay bed.

Section of the Claiborne bluff.

It is bed No. 3 of this section, viz., the basal bed of the Claiborne escarpment that he supposed expanded to the north and included all fossil bearing rocks as far north as Black's bluff on the Alabama and Woods bluff on the Tombigbee. Between Tate's ferry and Upper Peach Tree on the Alabama, and between Woods bluff and Black bluff on the Tombigbee, beds 1 and 2 are found.

We recognize at once in this classification our upper Midway beds in No. 1, lower Lignitic beds in No. 2 and upper Lignitic and Lower Claiborne in No. 3.

Hale was evidently a close observer, for in speaking of the fossiliferous deposits of Clark county on "Bashui creek" he says that they: include nearly all the different species of testacea common in other parts of the series, together with many new ones, some of which are unique. Of the latter may be noticed a *Rostellaria*, differing from Lea's *R. lamarckii* in having a more attenuated rostrum, and a very prominent tubercle on the back of the body whorl [*Calypt. trinodiferus Con.*]. Also a species of *Voluta*, having a general resemblance to *V. luctator* of the London clay, but differing in a remarkable deposit of enamel behind the aperture, forming a large bourelet covering half the spire to the summit, enveloping also the folds of the columella, and otherwise flattening and deforming the symmetry of the aperture [*V. tuomeyi Con*]. Also a new species of *Tornatella*, shell robust, spirally fluted with flattened ribs, spire attenuated, two stout folds on the columella, outer lip denticulate [*Tornatellæa bella Con.*], etc., etc.

About simultaneously with Hale's explorations were the first beginnings of Michael Tuomey's studies of beds now classed in the Lignite stage of the Gulf slope. Upon being appointed professor of Geology in the University of Tuscaloosa it was one of his duties "to spend such portions of his time, not exceeding four months of each year, in exploring the State, in connection with his proper department, as the Trustees may consider for the advantage of the State."

These explorations commenced in 1847, and such extracts from the reports made to the Trustees, as were thought to be of general interest appeared in the newspapers of Tuscaloosa. In 1848 Tuomey was appointed State Geologist and in 1850 his First Biennial Report appeared. Therein his description of the Lignitic Eocene of Alabama reads as follows:

"A few miles southwest of Prairie Bluff, a very marked change may be observed in the face of the country. As the Dumas settlement is approached, the surface becomes broken, and the long-leaf pine is almost the sole occupant of the high and sandy ridges.

"Along the State road, the physical features of the country are such as could not be mistaken by any one who had studied the Tertiary of North or South Carolina. The same magnificent growth of pines, and the same sandy surface, scarcely concealed by the tufts of harsh wiry grass.

"About two miles north of Choctaw Corner, the surface beds are removed by the streams that flow into Horse creek. These little rivulets are shaded in their course by groves of magnolias of striking beauty, of which superb genus three or four species may be seen together: *Magnolia grandiflora*, two feet in diameter, and emulating in height the tallest trees of the forest; *M. tripetela*, with its long narrow leaves; *M. macrophylla*, and *M. auriculata*, all in the same clump.

"Some of the most remarkable beds of lignite in the State, are found upon each side of the point where the public road crosses the creek. On the west, the stream has encroached on the bank, and laid the deposit bare. The lignite has lost all traces of woody structure, is quite homogeneous and compact, resembling the black mud of peat-bogs, when partially dried. It is intersected by joints that cross it in various directions, and presents a sufficient disposition to split into laminæ, to remind one of cleavage. It is impossible, at this locality, not to recognize some of the steps in the conversion of vegetable matter into coal. This bed passes upwards into a black clay colored by intermixture with lignite, and rests upon a bed of blue and fine sand, which is sometimes sufficiently indurated to form sandstone ; the latter is better seen lower down the creek.

" *Section on Horse Creek.*

1.	Surface beds	
2.	Dark clay	3 feet
3.	Lignite	3 feet
4.	Blue sand, and sometimes sandstone	

" About a mile from Choctaw Corner, a highly interesting locality was pointed out to me by Mr. Worrel : at this place, I saw the preceding bed of lignite, with the addition on the the top of a bed of marl four feet thick, containing a considerable proportion of green sand, having embedded in it *Cardita planicosta*, and other easily recognized Eocene fossils ; the whole resting upon a stratum of blue sand.

"The following diagram exhibits the order of super-position, and thickness of the beds at this locality :

"*Section on Bashi Creek.*

1.	Hard limestone	4 feet
2.	Marl highly fossiliferous	25 feet
3.	Blue sand. Variable	
4.	Lignite and clay	6 feet
5.	Laminated clay, sand, and mud. Thickness undetermined	
6.	Lignite. Thickness undetermined	

"1. This is a bed of hard rock, differing in composition but little from the marl which underlies it, excepting in its greater hardness. It appears to overlie the marl pretty generally, for I found it at localities miles distant. When cut through by the streams, or fissured (which is often the case) from any cause, the marl below is washed out, and caves of small extent are formed.

"2. The marl of this bed presents all the characters of the substance so called in Virginia, excepting perhaps, that the fossils are in a finer state of preservation, than any found in the Eocene beds of that State. Green sand is also disseminated through this ; all the dark colored grains, however, do not belong to this mineral. Green sand is readily distinguished by the green streak left, when a grain is crushed upon a piece of white paper, with the moistened point of a knife.

"3. This is a bed of bluish sand, the thickness of which was concealed, as the section is only traced by following the stream in its downward course along its channel ; the beds being often in part concealed from the sliding down of the surface beds.

"4. The overlying black, tenaceous clay, and lignite of this part of the section, differ in no respect from a similar bed already described. In the laminated clay, leaves of dicotyledinous plants are not uncommon.

"5, 6—Represent beds seen on another part of the stream below the preceding.

"The following are among the most abundant fossils at this locality :

Ostrea compressirostra.
Cytherea.
Cardita planicosta.
Rostellaria velata.
Actæon pomilius.
Voluta sayana?
Cardium nicolleti.
Infundibulum trochiformis.
Solarium.

"The oyster shells found here are large and and ponderous, and resemble very closely a variety of *O. compressirostra* found on Santee canal, South Carolina.

"*Rostellaria velata* has a longer and more attenuated canal than the Claiborne fossil. *Cardita planicosta* is in finer preservation than I have seen it elsewhere, The fossil that I have referred with doubt to *V. sayana*, at certain stages of growth, has a thick callus on the columella, which partly conceals the spire.

"Whether this be a prolongation of the Claiborne bed or not, I am as yet unable to decide. The mineral composition is different ; and although the greater number of fossils are identical with those of Claiborne, yet as a group they are very distinct, besides containing forms not found at that locality. But these differences, considering the wide interval between the two localities, are quite consistent with their identity.

"Five or six miles south of Choctaw Corner,* and on the east of the way to Macon, on the road to Tallahatta springs, thick ledges of rock are seen outcropping toward the top of the hills, and associated with a stratum of white silicious, and in some places indurated, clay. The surface of the beds of rock is often covered with silicified shells, much broken up, but often capable of being determined. I found here *Cardita planicosta*, and *Petcunculus idoneus*. I traced these beds to Tallahatta springs, where, on the top of a hill, this rock had been quarried for millstones. The hills capped with this white silicious clay, conspicuous throughout this region, are known between the Springs and the Corner, as chalk hills. It was easy to recognize these beds so characteristic of the Buhr-stone formation of Georgia and South Carolina. Still, I am in doubt as to the position of this fossiliferous formation, in relation to the fossiliferous beds of Choctaw Corner.

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* This name is now transferred from the place indicated on the map, to where the post office is kept.

"The country is here really hilly and broken, and a ridge extends across to the west side of the Tombigbee, where, 13 or 14 miles north of Barrytown, it overlooks the valley of the river. Taken altogether, the Buhr-stone formation gives rise to the most rugged and hilly region of the lower part of the State, and it is equally remarkable for sterility of soil.

"On a stream, called in the neighborhood Etishlakare, about 15 miles north of Barrytown, beds of marl occur similar to those on Bashi creek, and this is the farthest north that I have been able to trace them, and at this locality the order of super-position is equally uncertain."

From this it appears that Tuomey had not yet realized the true stratigraphic position of the Lignitic beds about Bashi creek. The "*Voluta sayana*" referred to by Tuomey was afterwards, 1853, described by Conrad as *Athleta tuomeyi*. Conrad adds: Mr. Tuomey says the group of fossils in this locality [Bashi creek, Clark county,] are very distinct from those of Claiborne, and I have no doubt the deposit will prove to be an upper bed of the Eocene which may, when the fossils are all collected, be found to contain some of the species of the Older Miocene as it occurs at Vicksburg, Miss. "The *Athleta tuomeyi*, though a very distinct shell, is related to a Miocene fossil of Dax (*A. rarispina*), which is an abundant species."

In 1864 Conrad described *Turritella præcincta*; in 1857 he described *Calyptraphorus trinodiferus* "from the Eocene of Alabama, Dr. Showalter."

In 1856 Prof. A. Winchell read before the American Association for the Advancement of Science some "Notes on the Geology of Middle and Southern Alabama." He recognized certain beds at the base of the Eocene, including the Midway stage of to-day and perhaps some Lignitic beds, as distinctly older than the Buhr-stone and constituting the base of the Eocene series.

Winchell accordingly classified the lower Midway beds as known to-day ,with perhaps some Lignitic beds, as Buff sand, immediately above which came his Buhr-stone. He apparently overlooked the fact that Hale eight years before had set off the lignite sands and clays (No's. 1 & 2) as distinctly older than the beds to the south, afterwards referred to the Buhr-stone and now classed as Lower Claiborne and upper Lignitic.

After Tuomey's death his 2nd Biennial report was edited by J. W. Mallet, 1858, and lists of fossils are given in the various appendices of the work from Nanafalia bluff and Bell's landing. It appears that he and his assistants had explored with some care nearly all the Eocene district of the State, but the report is extremely fragmentary and nowhere do we find a definite statement of the stratigraphic relations of the Lignitic deposits to those farther south. The term Buhrstone seems to have been used to designate the lower moiety of the Eocene in Alabama.

After Tuomey's death and Winchell's departure from Alabama, Dr. Showalter of Uniontown, Alabama, sent Conrad of the Philadelphia Academy several new molluscan fossils now known to have come from Lignitic outcrops, though their horizon and location is vaguely defined by Conrad as "a locality farther north in Alabama than any Mr. Tuomey had explored." These include *Exilia pergracilis*, *Simpulum showalteri*, *S.* (*Epidromus*) *exilis*, *Con.*, *Murex morulus Con.*, *Pseudoliva tuberculifera Con.*, *Acteonina subvaricata Con.*, *Tornatellæa bella Con.*, *Turbonilla trigemmata Con.* Others collected by T. J. Hale reached the cabinet of James Hall and were described in 1865 by R. P. Whitfield. They include *Pyrula juvenis*, *Fulgur triserialis*, *Pleurotoma nasuta*, *P. capax*, *Voluta newcombiana*, *Natica erecta*, *N. perspecta*, *N. onusta*, *N. alabamiensis*, *N. aperta*, *Velutina expansa*, *Potamides alabamiensis*, *Turritella eurynome*, *T. multilira*, *Cucullæa macrodonta*, and *Crassatella tumidula*.

Early in the seventies Prof. E. A. Smith began investigating the coastal plain of Alabama ; and as early as 1880 he sent collections from Bashi creek and Woods bluff, to the Philadelphia Academy for identification. Prof. Heilprin correlated these deposits with those of upper Marlborough and Piscataway rivers, Maryland, and Pamunkey river, Virginia, listed the species and described in the Academy's Proceedings as new: *Cytherea nuttalliopsis*, *Pseudoliva scalina*, *Lævibuccinum lineatum*, *Fusus subtenuis*, *F. interstriatus*, *F. engonatus*, *Strepsidura subscalarinus*, *Pleurotoma moniliata*, *Pyrula multangulata*, *Solarium cupola*, *S. delphinuloides*, *Dentalium micro-stria*.

The next year Prof. Heilprin furnished the Proceedings with some "Notes on the Tertiary Geology of the Southern United States." From Smith's notes he gives a section at Woods bluff, near the mouth of Bashi creek, and also a crude diagram representing the Woods bluff beds as passing beneath, i. e. stratigraphically below the "Buhrstone." He coins the term Eo-lignitic for these sub-buhrstone deposits and thus subdivides the whole Alabama Eocene:

4.	"White limestone" (Jacksonian)	50? feet
3.	Claibornian	17 feet
2.	"Buhrstone" (Siliceous Claiborne of Hilgard) about	250? feet
1.	Eo-lignitic	50? feet

Practically the same conclusions are reiterated in "Contributions to the Tertiary Geology and Paleontology of the United States" published in 1884, though attention is called to Johnson's note in Science, vol. ii, 1883, indicating a considerably greater extension of the Eocene to the northward than geologists were generally aware of.

It is, however, to Prof. Smith that our present knowledge of the Lignitic stratigraphy of the State is mainly due. His labors in this field he briefly summrizes as follows:

"During the summer of 1883 a trip was made by the authors, in a small steamer, down the Tuscaloosa (also called Black Warrior or Warrior) river, from Tuscaloosa to its confluence with the Tombigbee, down the latter stream to its confluence with the Alabama, down the Alabama and Mobile rivers to the head of Mobile bay, and thence up the last two rivers to Prairie bluff.

* * * * * * *

"The trip by steamer was made at the joint expense of the U.S. Geological Survey and the Geological Survey of Alabama.

"The first draft of this bulletin was prepared with the data collected during this trip, there being added thereto information gathered by myself in 1872, 1880, 1881, 1882, and 1884 for the Geological Survey of Alabama and for the Tenth Census of the United States and information obtained by Mr. L. C. Johnson in 1881, 1882, and 1883. The bulletin was not completed until I had gone over the whole ground again, in the summer of 1885, in company with Messrs. T. H. Aldrich and D. W. Langdon, of the Geological Survey of Alabama. Finally, the results of my investigations in the same region during the summer of 1886 have been in large part incorporated."

During this field work, extensive collections of Eocene fossils were made by members of the State Survey and Mr. T. H. Aldrich; and the latter prepared from this material an illustrated monograph on the Eocene mollusca of the State (Bull. 1, Geol. Surv. Ala., 1886.)

The stratigraphic work was published as Bull. 43 of the U. S. Geological Survey, and, therein the following subdivisions and names were included under the Lignitic :

Lignitic.	Hatchetigbee	175 feet
	Wood's bluff	80 to 85 feet
	Bell's landing	140 feet
	Nanafalia	200 feet
	Matthews landing & Naheola	130 to 150 feet
	Black bluff	100 feet
	Midway	25 feet

These works, it will be observed, bear mainly upon the Eocene stratigraphy as shown along the Alabama and Tombigbee rivers. But D. W. Langdon, an assistant on the State Survey, continued the work on eastward, and in 1890 read before the American Geological Society a paper embodying many of his conclusions on deposits farther east.

In 1894 the State Survey published a report embodying among other matter all the then known Lignitic stratigraphy. The Alabama type section was revised to read :

	Feet.
Lignitic.	
a. Hatchetigbee	175
b. Bashi or Wood's bluff	80 to 85
c. Tuscahoma or Bell's landing	140
d. Nanafalia	200
e. Naheola or Matthews' landing	130 to 150
f. Sucarnochee or Black bluff	100
Clayton (Midway)	25 to 200

It will be observed here that the Midway has been separated out from the Lignitic, but that the Matthews' landing and Black bluff beds are still retained in this stage.

The distribution of the different substages of the Lignitic are shown on a large geological map of the State accompanying this work.

Since the publication of these stratigraphic works Mr. Aldrich has written two Bulletins (Bull. Amer. Paleont. No's 2 & 8) describing among other Eocene shells many from the Lignitic stage. The present writer has also contributed an article to the Proceedings of the Philadelphia Academy of Natural Sciences wherein are described and figured several Lignitic species.

Stratigraphy.—In passing down the Tombigbee from the last characteristic Midway exposure, viz, Naheola, various bluffs are seen on either side of the river, blackish and clayey at first but becoming more grayish or yellow and arenaceous downstream, until the famous Nanafalia exposure is reached. Here fossils which seem to be exceedingly scarce in the stretch just described, become very noticeable. Here the river is deflected to the west principally or primarily by an indurated ledge of marl which shows a moderate southern dip. Its height above water depends accordingly upon the exact point examined and the stage of the water at the time.

The section as given by Smith and Johnson is as follows :

Section of Nanafalia landing, Tombigbee River.

" 1. Greensand marl, highly fossiliferous, containing chiefly *Gryphæa thirsæ* Gabb, but holding also *Turritella mortoni* Con., *Flabellum*, and a few other fossils. This marl makes a tolerably firm rock, with a line of indurated, projecting bowlder-like masses 12 to 18 inches thick of nearly similar material along the whole length of the bluff and near the middle of the bed..........about 20 feet.

" 2. Dark blue, almost black, laminated clay, devoid of fossils, but passing below gradually into a bluish marl...3 to 4 ft.

" 3. Bluish greensand marl, with a few shells in the upper 3 or 4 feet, but more highly fossiliferous below. This bed contains a great variety of beautifully preserved and easily detached fossils. The fossils can be collected only during very low stages of the water.......................8 to 10 feet.

It is from the under side of the indurate masses that break off and are turned on one side or bottom side up along the cliff that our best fossils were obtained. Numerous cavities are noticeable all along this ledge where huge *Venericardia planicosta* and *Ostrea compressirostra* have been dissolved out. But by far the most characteristic fossil of this horizon is the *Gryphæa thirsæ* of Gabb. Other fossils are: *Venericardia alticostata* var., *Crassatella halei*, *Cardium tuomeyi*, *Pectunculus*, *Levifusus pagoda* (very large and spinous), *Turritella humerosa*, *T. mortoni*, *Cornulina armigera*, *Calyptraphorus trinodiferus*, *Volutilithes petrosus*, *Capulus complectus*, *Mesalia alabamiensis* (2 var.) *Pseudoliva scalina*, *et. al.*

In going down the river below Nanafalia a characterstic feature of the outcrops is the number of enormous concretions they exhibit. These show clearly that the dip of the strata is southward, though reverse dips and local unconformities are noticeable. Dark lignitic and grayish sands, more or less indurated prevail for a number of miles. At Tuscahoma landing there are no such fossiliferous beds as at Nanafalia, yet Aldrich has secured from them several new species. The species noted by the writer are: *Turritella mortoni*, *T. præcincta*, *Levifusus pagoda* *Volutilithes petrosus*, *Calyptraphorus trinodiferus*, *Pleurotoma capax*, *Venericardia planicosta*, *Pectunculus sp.* These were picked out from the bank four feet above water level (about July 1) just below the landing.

The next outcrop of any considerable importance is formed by a low bank on the south side of the river as the latter swings westward, near the mouth of Bashi creek. The fauna is decidedly upper Lignitic and hence is closely allied to that of Woods bluff. Here were obtained: *Ostrea* var. *sylværupis*, *Meretrix nuttalliopsis*, *Corbula aldrichi*, *C. concha*, *Cornulina armigera*, *Hemifusus engonatus*, *Volutilithes petrosus*, *Pseudoliva vetusta*, *Tornatellæa bella*, *Pleurotoma tombigbeensis*, *Pleurotoma sp.*

The next well known fossiliferous outcrop is at Woods bluff. Here the following beds were observed:

1.	Soil, sand, pebbles at base	40 feet
2.	Black clay, about	8 feet
3.	Line of concretions	4 inches
4.	Fossiliferous reddish and variegated clay	3 to 6 feet
5.	Black clay	10 feet
6.	Reddish fossiliferous sand	2 feet
7.	Fine gray fossiliferous sand	5 feet

8. Concretions with large *O.* var. *sylværupis*............ 3 feet
Water level..

Fossiliferous sands below No. 8 have furnished, during extreme low water, a fine fauna, specimens from which were figured in the writer's recent article in the Philadelphia Academy's Proceedings. No. 8 is a concretionary layer in part, and in part simply an indurated band averaging two or three feet in thickness with very uneven and undulating superior and inferior surfaces. In these indurated layers are found large and well defined *Ostrea* var. *sylværupis*. No. 7 contains a very rich fauna. No. 6 is but a sandy, grayish fossiliferous phase of No. 5 and contains *Clavilithes*. No. 4 is not so fossiliferous as No. 7, but contains many well preserved specimens of *Volutilithes petrosus*, and *Levibuccinum striatum*.

The more common species from this now famous exposure have already been listed by Heilprin and Aldrich.

At Coffeeville a lower Claiborne deposit occurs, but several miles below at Hatchetigbee bluff an uppermost Lignitic outcrop is found. For perhaps 20 feet above water line finely laminated dark clays predominate. Towards the lower end of the exposure or cliff there is an upstream dip which brings to day two or three layers of *Venericardia planicosta* often with valves united, almost as perfect as the shells strewn along the shores of modern seas. In with these *Venericardia* one observes *Pseudolivæ* and an occasional *Cornulina*. From 10 to 20 feet above water level one finds concretions, and, adhering to their lower surface are not a few well preserved shells. Ledges of light colored material (buhrstone?) occur here and there from 20 feet upwards, but brownish clays predominate. High up in the latter one finds the most and best fossils. This bluff has furnished Aldrich and the writer several new species, some of which have been named after the bluff—*hatchetigbeensis*.

About three miles north of Pine Hill there is a railroad cut which exposes at its northern terminus—about ⅙ mile south of Turkey creek—about five feet of light clay with a few rather obscure fossils in its uppermost layers. By passing southward it will be seen that a ferruginous greensand containg a fauna of Naheola affinities overlies the clay. *Astarte* var. *mediavia* is quite common here. Other clays appear, some bearing quartz pebbles and some laid down more or less unconformably upon each other ; thickness 20 feet. At the summit of these deposits there is a fossiliferous streak containing quite a number of small, imperfect oysters. Perhaps 20 feet higher still, and at the south end of the cut a bed of *O. thirsæ* comes in. Beds of this species stretch along the railroad for over a mile towards Pine Hill. A few *Venericardia planicosta* and *Turritella mortoni* are sprinkled in here and there. This section is interesting, for it shows within a few feet the dividing line between the Lignitic and Midway stages.

Along the Alabama river south from the famous Matthews' landing outcrops of Midway clays beds of dark sandy and lignitic clays give place to the Nanafalia marls at Gullettes' landing, replete with *Ostrea thirsæ.* The best collecting ground, however, does not appear until Yellow bluff is reached. This is practically the same fauna as that at Gregg's landing. Large specimens of *Ostrea compressirostra* and *Venericardia planicosta* are fairly abundant, but the fauna is principally of gastropods, including *Turritella mortoni*, *T. humerosa*, *T. præcincta*, *Mesalia alabamiensis*, *Calyptraphorus trinodiferus*, *Voluta newcombiana*, *Pseudoliva vetusta*, *Fusus harrisi*, *Cornulina armigera*, *Levifusus pagoda*, *L. trabeatus*, *Natica limula*, *N. aperta*, *N. eminula*, *Pleurotoma nasuta*, *et. al; Pecten greggi*, and *Crassatella halei* are typically developed here.

Gregg's landing some miles below is perhaps the best lower Lignitic collecting ground in the State. There is no mass of fossils from which large quantities of any given species can be obtained, but by diligently picking over the cliff, from one end to the other a great variety of mollusca as well as corals can be obtained.

Farther downstream at Peeble's and Lower Peach Tree landing outcrops occur, not important for the number and variety of their fossil fauna, but containing noticeably large concretions, reminding one of the Tombigbee river above Tuscahoma.

Bell's landing, another very important outcrop, can be passed over with only a passing mention, for its strata and fossils have been studied with considerable care by Smith, Johnson and Aldrich. This is the last good exhibition of lower Lignitic beds on the Alabama.

Four miles above Hamilton bluff, as the river sweeps westward before its final southern deflection through the "Buhrstone" at Hamilton bluff, there is a low outcrop of upper Lignitic or Woods bluff marls on the southern bank of the river.

Some of the fossils collected here are: *Venericardia planicosta*, *Meretrix nuttalliopsis*, *Pectunculus idoneus*, *Corbula aldrichi*, *Plicatula filamentosa*, *Leda parva*, *L. protexta*, *Solemya alabamiensis*, *Pseudoliva vetusta*, *Calyptraphorus trinodiferus*, *Natica clarkeana*, *Fusus subscalarinus*, *Solariella sylværupis*, etc.

At Hamilton bluff white Buhrstone is the predominant rock.

It is much to be regretted that time and circumstances did not permit visiting the Woods bluff exposures described by Langdon, near Elba on Pea river. Ozark, however, is easily accessible by railroad and although the fossils near by are not well preserved, they do indicate very clearly the stages of the Eocene to which they belong. In the deep cut on the Midland railroad as it passes beneath the Savannah and Western, there is a layer about four feet thick, filled with fragments of shells, some being apparently whole but crumbling generally when removed from the matrix. The base of this stratum is from two to four feet above the railroad track, while below and above it are layers of nearly barren black clay.

It is difficult to see why this outcrop has been referred to the Claiborne horizon, for it is characterized by a very typical upper Lignitic or Woods bluff horizon. Some of the fossils are *Venericardia planicosta*, *V. alticostata*, *Leda protexta*, *Corbula aldrichi*, *Leda elongatoidea*, *Meretrix nuttalliopsis*, *Astarte smithvillensis*, *Turritella clevelandia*, *Fusus interstriatus*, and many others.

On the Savannah and Western road about 200 yards north of this cut, Buhrstone deposits occur on the east side of the track. This outcrop may be 38 feet above the cut.

Georgia.

References. — *10th Census U. S., vol. vi, Cotton Production, part ii, p. 280, 1884,—Loughridge. Bull. Geol. Soc. Amer., vol. ii, pp. 600–602, 1891, — Langdon. Geol. Surv. Ala., Rep't on Coastal Plain of Ala., pp. 406–419, 1895,—Langdon. Geol. Surv. Ga., 1st Rep't, pp. 46–47, and map p. 16, 1891,—Spencer. Amer. Geol., vol. 18, p. 236, 1896,—Harris.*

Near Ft. Gaines, Georgia, the following stages and strata have been observed, commencing about five miles east of the bluff:

1. Vicksburg cherty limestone (5 miles east of Ft. Gaines).. – feet

2.	Not well exposed; unfossiliferous where observed	40 feet
3.	Buhrstone, quarries 2 miles east of Ft. Gaines	10 feet
4.	Unfossiliferous Lignitic sands, 2-½ miles east of Ft. Gaines	70 feet
5.	Unexposed to top of bluff	20 feet
6.	Red clay, sand, and gravels (Pleistocene)	25 feet
7.	Lignitic clay	20 feet
8.	Fossiliferous sandstone ledge, *O. compressirostra*	3 feet
9.	Blue clay	6 feet
10.	Alternating hard and soft layers	20 feet
11.	Fossiliferous indurated marl (seen in bed of branch)	3 feet
12.	Bluish sandy clay	30 feet
13.	Sandy clay with concretions, *Ostrea thirsæ*	20 feet
14.	Midway limestone (See Bull. Amer. Paleont. No. 4.)	
	Water level	

This is certainly an interesting locality, showing as it does the Vicksburg and Midway beds in such close proximity. The Nanafalia and Yellow bluff horizon, viz., the lower Lignitic, is well represented and fossiliferous, while so far as observed the beds probably belonging to or representing an upper Lignitic horizon are barren. The lower Claiborne light colored sandstones east of the village are not thick, but carry an ample fauna, with the same species as seen at Hamilton bluff on the Alabama and along the Savannah and Western road perhaps ¾ mile north of Ozark.

Vicksburg beds form the surface rock at Cuthbert and three miles to the north. They occupy high hills as far as five miles north of this town. Nine miles to the north of Cuthbert Midway beds crop out on the northern slope of a hill. The estimated distance between the top of the Midway and the base of the Vicksburg is 200 feet. An exposure of no less than 100 feet of Lignitic and lower Claiborne exposure is seen in a deep valley 3½ miles north of town. Here and farther east, at least as far as Macon, no fossiliferous beds belonging to the Eocene series have been detected between the Vicksburg and Midway.

List of stratigraphic terms that have been applied to all or part of the Lignitic stage.

Alluvial rocks., *partim*, Maclure; Trans. Amer. Philos. Soc., vol. 6, map, 1809; vol. 1, New series, map.

Alluvial, *partim*, Cornelius; Amer. Jour. Sci., vol. 1, p. 324, 1819.

Alluvial, *partim*, Nuttall; Jour. Acad. Nat. Sci. Phila., vol .2, p. 42, 1821.

Bashi, Langdon; Bull. Amer. Geol. Soc., vol. 2 p. 596, 1891.

Bashi (*or Woods bluff*,) Smith and Johnson; Bull. 43, U. S. Geol. Surv., pp. 18 and 43, 1887.

Bell's Landing group, Smith and Aldrich; Bull. 1 Geol. Surv. Ala., p. 54, 1886.

Bell's landing, Smith and Johnson; Bull. 43, U. S. Geol. Surv., pp. 18 and 46, 1887.

Bluff lignite, Safford; Geol. Tenn., p. 428, 1869.

Buff sand, *partim*, Winchell; Proc. Amer. Assoc. Adv. Sci., vol. 10, p. 87, 1857.

Buhrstone, *partim*, Winchell; Proc. Amer. Assoc. Adv. Sci., vol. 10, p. 87, 1857.

Camden beds, Hill; Ann'l Rep't Geol. Surv. Ark., 1888, vol. 2, p. 188.

Camden series, *partim*, Hill; Ann'l Rep't Geol. Surv. Ark., 1888, vol. 2, pp. 49 and 188.

Eo-lignitic, Heilprin; Proc. Acad. Nat. Sci. Phila., 1881, p. 159; and Cont. to Tert. Geol. and Paleont. U. S., p. 30, 1884.

Fossiliferous clays at Ft. Gaines, Ga., Loughridge; Cotton Prod. Rep't 10th Census, part. 2, p. 280.

Gregg's landing marl, Bull. 1, vol. vi, Geol. Surv. Ala., p. 12, 1886.

Gryphæa thirsæ marl (*or Nanafalia*,) Smith and Johnson; Bull. 43 U. S. Geol. Surv., p. 39, 1887.

Heatchetigbee group, Smith and Aldrich; Bull. 1, Geol. Surv. Ala., p. 50, 1886.

Hatchetigbee, Smith and Johnson; Bull. 43, U. S. Geol. Surv., pp. 18 and 39.

Hatchetigbee, Langdon; Bull. Amer. Geol. Soc., vol. 2, p. 596, 1891.

Lagrange group, Loughridge; Rep't on Jackson's Purch. Reg., Geol. Surv. Ky., p. 52, 1888.

Lignitic, partim, Clark ; Bull. 43, U. S. Geol. Surv., p. 58, 1891.

Lignitic, Vaughan ; Amer. Geol., vol. 15, p. 209, 1895 ; Bull. 142, U. S. Geol. Surv., 15, 1896.

Lignitic, partim, Smith and Johnson ; Bull. 43, U. S. Geol. Surv. pp. 18 and 38, 1887.

Lignitic beds, Dumble ; Geol. Surv. Tex., Report on the Brown Coal of Tex., p. 130, 1892.

Lignitic stage, Harris ; Ann'l Rep't Geol. Surv. Ark., 1882, vol. 2, p. 55.

Lignitic, Harris ; Amer. Jour. Sci., (3), vol. 47, p. 304, 1894.

Lignitic, Harris ; Dana's Manual of Geology, p. 888, 1895.

Lignitic group, Loughridge ; Rep't Jack's Purch. Reg., Geol. Surv. Ky., p. 41, 1888.

Little Missouri Lignites, Hill ; Ann'l Rep't Geol. Surv. Ark., 1888. vol. 2, p. 188.

Lower Eocene or Lignitic series, partim, Spencer ; Geol. Surv. Ga., 1st Rep't, p. 43, 1891.

Lower Tertiary, partim, Conrad ; Proc. Nat. Inst., 2d Bull., p. 179, 1841.

Manchester shales, Hill ; Ann'l Rep't Geol. Surv. Ark., 1888, vol. 2, p. 188.

Miocene, L. Harper ; Prelim. Rep't Geol. and Agr. Miss., 1857.

Nanafalia group, Smith and Aldrich ; Bull. 1, Geol. Surv. Ala. p. 58, 1886.

Nanafalia, Smith and Johnson ; Bull. 43, U. S. Geol. Surv., pp. 18 and 51, 1887.

Nanafalia, Langdon ; Bull. Amer. Geol. Soc., vol. 2, p. 596, 1891.

Northern Lignitic group, (exclusive of the "Post Oak Flatwoods"), Hilgard ; Rep't Geol. and Agr. Miss., 1860, vol. 1, p. 110.

Orange sand or Lagrange group, Safford ; Geol. of Tenn., 1869, p. 424.

Secondary rocks, partim, Maclure ; Trans. Amer. Philos. Soc., vol. 6, map, 1809; vol. 1. New series, map.

Timber belt or Sabine river beds, partim, Penrose ; Ann'l Rep't Geol. Surv. Tex., vol. 1, 1889, p. 22.

Tuscahoma, Langdon ; Bull. Amer. Geol. Soc., vol. 2, p. 596, 1891.

Woods bluff group, Smith and Aldrich ; Bull., Geol. Surv. Ala., p. 51, 1886.

Woods bluff, Smith and Johnson ; Bull. 43, U. S. Geol. Surv., pp. 18 and 43, 1887.

* * *

SECTION II. PALEONTOLOGY.

OSTREA.

Ostrea compressirostra, Pl. 1, 2, 3; and pl. 6, fig. 1, (2?)

Syn. *O. compressirostra* Say, Jour. Acad. Nat. Sci. Phila., vol. 4, p. 132. pl. 8 fig. 2.
O. bellovacina Con., Proc. Nat. Inst., 1842, p. 172.
O. compressirostra (Tuomey) Thornton, 2d Bien'l &c., p. 270, 1858.
O. bellovacina Con., non Lam., Con., Amer. Jour. Conch., vol. 1, p. 15, 1865.
O. compressirostra Heilprin, 3d Ann' Rep't U. S. G. S., p. 309, pl. 65, 1884.
O. compressirostra Ald., Bull. 1, Geol. Surv. Ala., p. 57, 1886.
O. compressirostra Langdon, Bull. Geol. Soc. Amer., vol. 2 p. 603, 1890.
O. compressirostra Har., Amer. Jour. Sci., 3d ser. vol. 47, p. 302, 1894.
O. compressirostra Say, Bull. Amer. Paleont., vol. 1, p. 308, pl. 27, fig. 2, 1846.

Say's original description.—(See Bull. Amer. Paleont., vol. 1, p. 308.)

Plate 1 shows the original figure of the species. It represents a very common though not a well developed phase of the species. Plates 2 and 3 represent different views of an uncommonly well developed and well preserved specimen.

Say, Conrad, Heilprin and others have noted the strong resemblance which this species bears to *O. bellovacina* of the Old World. To any American, collecting at the type locality of the latter species, near Beauvais (Butte de la Justice), the resemblance between the *Ostreæ*, *Crassatellæ* &c., found there and those found in the lower Lignitic beds of his own conntry, seems most striking. But by comparing these representative species side by side certain differences are sure to be brought out. The plication on the outer surface of *compressirostra* is loose, uneven, and sometimes not well defined, while in *bellovacina* it is comparatively sharp and well defined. It is well represented in Deshayes' Description des Coquilles Fossiles des Environs de Paris, pl. 48, fig's 1, 2; pl. 49, fig's 1, 2; pl, 50, fig. 6. The muscular impression is reniform and not pyriform as in *compressirostra*; there is a lack of anterior alation in the larger valve, and the dehiscence or marginal flexture is lower down on the posterior margin. Searles V. Wood, in his monograph of the Eocene mollusca &c. published by the Paleontographical Society, 1861, says, p. 18, regarding a specimen brought from the New World by Charles Lyell: "I have seen a specimen, in Sir Charles' cabinet, from Virginia, (without a name), which, in some characters resembles *O. pulchra;* I can scarcely think it strictly identical either with it, or with *bellovacina.*"

Heilprin has already called attention to the fact (3d Ann'l Rep't U. S. Geol. Surv., p. 310) that the species from "Grove," S. C., referred by Lyell to *O. bellovacina* (Proc. Geol. Soc. Lond., Feb. 1845, p. 567) should probably have been referred to *O. carolinensis* Con. We have already shown (Bull. Amer. Paleont., vol. 1, p. 159, 1896) that certain specimens referred to this species by Langdon, are really another species, called first by Gabb., *Q. crenulimarginata.* Below we will show how others from the upper Lignitic should be classed as a third species, *O.* var. *sylværupis.*

This species is extremely abundant and often of large dimensions at Bell's Landing and Ft. Gaines.

Localities (exclusive of Md. and Va.).—Alabama: Nanafalia, Tuscahoma, Yellow Bluff, Gregg's Landing, Bell's Landing. Georgia: Ft Gaines,

Ostrea trigonalis var. **sylværupis,** Pl's 4 and 5. Pl. 6, figs. 3, a, 4.

Syn. *O. compressirostra* Tuomey, 1st Bien. Rep't, p. 146, 1850.
O. carolinensis Con., Amer. Jour. Sci., vol. 40, p. 266, 1865.
O. probably young of *thirsæ* Gabb, Ald., Bull. 1, Geol. Surv. Ala., 1886.
O. compressirostra Smith and Johnson, Bull. 43, U. S. Geol Surv. p. 44, 1887.

It is in deference to Dall's opinion that this form is referred to as a variety of *trigonalis* Con., Proc. Acad. Nat. Sci. Phila., 1855, p. 259, and Wailes' Agr. and Geol. Miss., 1854, pl. 14, fig. 10. We have here but a half dozen rather imperfect specimens of *trigonalis* while at the National museum, the material from the Jackson beds is far more satisfactory. Our specimens of *trigonalis* are not so quadrangular nor so incrassated as *sylværupis.* The more important features of the latter are as follows:

Quadrangular or broadly oval in outline; valves very thick and of a silicious granular texture: left valve very convex and heavy; exterior sometimes marked by faint and irregular costations; interior showing a moderately deep ligamental pit with small lateral areas, an elliptical-circular muscular scar situated very near the center of the valve, a slight dehiscence anteriorly, and a stronger one posteriorly, and profound depression central-posteriorly for the soft parts; right valve operculate, somewhat sinuate anteriorly and posteriorly to partially or wholly counteract the gaping tendency of the left valve; ligamental pit not deep, but well defined, with moderate lateral areas; muscular impression elliptical-circular; greatest thickness just within the periphery.

This form has for some time been a source of annoyance to the writer, for it certainly has characters in common with *O. compressirostra*, *O. carolinensis*, *O. trigonalis*, and *O. sellæformis*. It is from the Lignitic horizon, hence in *O. compressirostra* one would expect its closest ally. It differs, however, from *O. compressirostra* by its circular-quadrate form, incrassated valves, circular muscular impression, paucity of ribs in adult form, and entire want of the same during earlier stages of growth.

This species is doubtless the one referred to by Tuomey in his 1st Biennial Report, p. 146, for he says the shells are large and ponderous and resemble very closely a variety of *O. compressirostra* found on Santee canal, South Carolina. This statement evidently led Conrad to supppose, Amer. Jour. Sci., 2d ser., vol. 40, p. 266, 1865, that this oyster was really *O. carolinensis* described by himself in 1832, Foss. Shells, Tert. Form, p. 27, pl. 14, and he makes this amendment in Tuomey's list. Heilprin, however, states that in the copy of Tuomey's report in the Philadelphia Academy the following is written in pencil *a propos* of Tuomey's list : " All doubtful except *Venericardia planicosta*. T. A. Conrad." Heilprin does not specifically identify the oysters contained in the collections he studied and reported upon from Knight's and Cave Branches and Woods Bluff for Dr. E. A. Smith, Proc. Acad. Nat. Sci., 1880 pp. 364–366; nor does Aldrich give specific names to these forms in Bulletin No. 1 of the Alabama Survey, 1886. The young form here shown pl. 6, figs. 3, 4, he doubtless refers to as "Ostrea (probably *O. thirsæ*)"

Smith and Johnson, however, in Bull. 43, U. S. Geol.Surv., p. 44, 1887, designate this oyster as "*O. compressirostra* Say, with very thick and ponderous shells."

True it is we may yet doubt whether the numerous thin young oysters, found for example, in the upper part of the Woods bluff outcrop, are the representatives of the full grown specimens in the concretionary layers below. Yet we have seen an approach to this young state made by *O. compressirostra* and *O. crenulimarginata*, though in these there is generally at least some trace of ribbing, and the muscular scar is heart-shaped as in the adults.

Pl. 6, fig's 3, 4, represent what we regard as the young of this species. Pl. 6, fig. 1, is a young *O. compressirostra*. That these are not Gabb's *Gryphæa thirsæ* is evident from the marked differences shown in thickness, obliquity, form of muscular scars, and above all by differences in direction of lines of growth.

Localities.—Alabama : Woods Bluff; three miles southwest of Thomasville; near the mouth of Bashi creek. It may be expected wherever Woods Bluff beds crop out.

Ostrea thirsæ, Pl. 6, figs. 5, 6.

Syn. *O. emarginata* Tuomey, (name only) 2d Biennial Rep't Geol. of Ala., 1858, p. 269.
Gryphæa thirsæ Gabb, Proc. Acad. Nat. Sci. Phila., 1861, p. 329.
Ostrea thirsæ Heilprin, 3d Ann'l Rep't U. S. Geol. Surv., p. 311, pl. 63, fig's 4, 5, 6.
Gryphæa thirsæ Aldrich, Bull. 1, Geol. Surv. Ala., p. 58, 1886.

Gabb's original description.—"Rounded sub-trinangular. Lower valve; beak very small, and close to the hinge, nerver exsert Umbone rounded, very prominent and somewhat compressed laterally, the rounded elevation continuing more or less regularly, becoming broader, to the middle of the basal margin, at which point this margin is always somewhat emarginate. Ligament area broad, triangular, transversely striate, and with a slight irregular depression in the middle. Interior of valve very deep. Muscular impression nearly ovoid, narrowest on the inner end. External surface marked by a few small, irregular squamose ridges, most numerous and distinct directly behind the emargination of the base. Upper valve unknown.

"The species resembles, remotely, some of the narrower forms of *G. vesicularis* Lam., but after comparing the series before me with numerous authentic specimens of that species, both American and European, some of the latter labelled by d'Orbigny and others, by Charlesworth, I am satisfied that they are distinct. The beak is so small as to be almost obsolete, and there is always a more or less distinct, rounded, umbonal ridge. In general form, it resembles *G.* (*Exogyra*) *columba*, but wants the spiral beak,and is never lobed. The small beak and absence of all traces of lobes will sufficiently separate it from *G. pitcherii.*

" The specimens are in the Museum of the Smithsonian Institute (No. 570), and are from a light gray sandy marl.

" *Locality.*—'Nanafalia,' Alabama.

"Length, 1.7 in. Greatest width, 1.3 in. Width at the hinge, .6 in. Greatest height of valve, .8 in. Height at the hinge, .7 in. Length from the basal margin, over the umbone, to the beak, 2.3 in."

Localities.—Alabama : R. R. cuts 1-2 mile north of Pine Hill ; Nanafalia ; Gullette's Landing ; Bell's Landing (scarce) ; Smith and Johnson report this species as abundant in Grampian Hills, south of Camden. Langdon reports it from Conecuh River, Sect. 21, T. 8, R. 19, E., and from Chattahoochee, between Ft. Gaines, Ga. and Wood's shoals.

Ostrea alabamiensis Lea. Pl. 6, fig. 7.

A few fragments were found at Hatchetigbee bluff that seem to belong to this species. The discussion of the species will more properly come in a future Bulletin on the Lower Claiborne stage.

Ostrea sellæformis Con. Pl. 6, fig. 2.

Aldrich has identified this species from Hatchetigbee bluff, Bull. Geol. Surv. Ala., p. 50 1886, and we have a few small and ill preserved specimens perhaps belonging to this species from the same locality, and 4 miles above Hamilton Bluff, on the Alabama, yet the identification is doubtful and the species had best be considered under the Lower Claiborne stage.

Plicatula filamentosa, var. Pl. 6, figs. 8, 9.

Syn. *P. filamentosa* Con., Foss. Sh. Tert. Form., Aug. 1833, p. 38.
P. mantelli Lea., Cont. to Geol., Dec. 1833, p. 89, pl. 3, fig. 68.
P. filamentosa Ald., Bull. 1, Geol. Surv. Ala., p. 50, 1886.

Conrad's original description.—" Shell suborbicular, narrowing toward the apex, much compressed; with seven costæ; and densely imbricated with small, irregular, concentric wrinkles, and with minute radiating lines. Breadth and length about ¾ of an inch.

" *Locality.*—Claiborne, Ala. Cab. Acad. N. S."

The variety in question differs from the typical Claiborne specimens by having 10 or 15 costæ and by its much smaller size. Yet there seem to be intermediate stages, and for the present it will be assumed that environment has caused the difference in the appearance of the two forms.

Localities (of this type).—Alabama : Hatchetigbee Bluff; 4 miles above Hamilton Bluff, Alabama River; Ozark, R. R. cut just below the Buhrstone.

ANOMIA.

Anomia, sp. Pl. 6, fig. 10.

Two very young specimens of this genus, one of which is herewith figured, were found at Hatchetigbee bluff. It seems inadvisable to attempt a specific characterization of such immature forms. However, one feature deserves special attention, viz. the peculiar grooves converging posterior to the muscular impressions and terminating in circular shallow depressions or pits. See figure.

Spondylus, sp. Pl. 6, fig. 11.

Syn. *Plagiostoma dumosum* Con., Foss. Sh. Tert. Form, 1835, p. 34.
Spondylus dumosus Ald., Amer. Jour. Sci., 3rd ser., vol. 30, p. 305, 1885.
Spondylns dumosus var. Ald., Bull. 1, Geol. Surv. Ala., p. 50, 1886.

We feel great hesitation in placing this upper Lignitic form in with Morton's *P. dumosum*. For his description (Synop. Org. Rem. Cret. G'p.,p. 59, 1834) argees exactly with well preserved specimens from Chickasawhay and other Vicksburgian localities, but it does not agree so well with the specimens now under consideration. Morton very properly remarks that *dumosum* has spines on both valves. Our specimen figured has none. Another smaller specimen of a right valve does show spines, but they are much finer and aciculate, the spine-bearing and intermediate costæ are more numerous than in *dumosus*. Again, the valves appear more oblique.

This subject will be discussed more fully in a future work on the Vicksburg stage.

Localities.—Alabama : Hatchetigbee Bluff ; Ozark, R. R. cut just beneath the Buhrstone.

Specimen figured.—From Hatchetigbee Bluff, in Cornell University collection.

Lima ozarkana, n. sp. Pl. 6. fig. 12.

Specific characterization.—General form and size as indicated by the figure ; ventricose; ligamental pit very broad, occupying a greater part of the hinge plateau ; surface marked by 25 or 30 sharply defined radiating raised lines, between which are secondary and sometimes tertiary systems of lines.

Locality.—Alabama : Ozark, R. R. cut, just beneath the Buhrstone.

Type figured.—From Ozark, Ala.; Collection of Paleont. Mus. Cornell University.

Pseudamussium claibornense, Pl. 7, fig. 1.

Syn. *P. claibornensis* Con., label, Phila. Acad. Museum.
Camptonectes claibornensis Con., Smithsonian Check List.
Pecten claibornensis Heilprin, Proc. Acad. Nat. Sci. Phila., 1881, p. 416.
Pecten claibornensis Har., Geol. Surv. Ark., Rep't 1892, vol. ii, p. 145.
Pecten claibornensis Har. Proc. Acad. Nat. Sci. Phila., 1896, p. 470, pl. 18 fig's 1 and 2.

It is quite possible that the little *P. scintillatus* figured and described by Conrad (Amer. Jour. Conch., 1865, p. 140, pl. 10, fig. 4.) is but a young or dwarfed specimen of this species. *P. claibornensis* has never been fully characterized, but was referred to by the writer in his Arkansas Report as follows: "This rather small, thin *Pecten* appearing smooth to the naked eye, when examined under a microscope is found to contain minute ex-curving radiate lines, especially near the anterior and posterior margins. It is fairly abundant at Moody's branch, near Jackson, Mississippi."

The specimens now under consideration are somewhat larger than those from Moody's branch, but there seems to be no valid reason for regarding the two forms as specifically distinct.

The resemblance of this species to *P. calvatus* Mort. is of course noticeable as Heilprin and others have observed, but if we mistake not, that species does show freqently well defined costæ, this is always smooth both within and without.

European representative.—*P. corneus* Sby., Min. Conch., pl. 204.

Locality (Lignitic).—Alabama : Hatchetigbee Bluff.

Specimens figured.— Hatchetigbee Bluff, Paleont. Museum of Cornell University.

AMUSSIUM.

Amussium squamulum, Pl. 7, figs. 2, a. 3.

Syn. *P. squamula* Lam., Ann. du Mus., vol. 8, p. 354, No. 3.
Lam., An. sans Vert., vol. 6, p. 183, 1819.
Desh., Coq. Foss. Env. Par., p. 304, pl. 45, fig's 16, 17, 18.
Dixon, Geol. Sussex, 1850, pp. 94-172, pl. 3, fig. 29.
Desh., Descr. des An. Sans. Vert., 1864, vol. 2, p. 74.

We have not had access to Lamarck's original description, but in his An. sans Vert., *l. c.* he says simply "*P. testa minimi, orbiculari, intus subocto-radiata.*" Deshayes, however, remarks p. 304, op. cit. "Cette coquille est la plus petite du genre; elle est arrondie, lenticulaire, très-déprimée, équivalve, équilatérale, à oreillettes égales, toute lisse en dehors et, comme le *Pecten pleuronectes*, ornée en dedans de côtes saillantes régulières et rayonnantes du summit à la base. Ces côtes sont étroites, égales, distantes, et elles varient dans les individus de huit à dix. La charnière est droite, linéaire, simple ; les oreillettes qui la prolongent sont égales un peu obtuses, semblables sur les deux valves, si ce n'est l'antérieure de la valve droite, qui est échancrée assez profondément à la base. Ces oreillettes sont grandes relativement à la taille de la coquille. Cette espèce, assez rare n'a que quatre à cinq millimètres de diamètre."

Again (Descr. An. sans Vert., p. 74) Deshayes says: "Cette petite espèce est peu commune. Elle apparaît dans cette partie des sables inférieurs qui se superpose aux lignites, et elle vient s'éteindre dans le calcaire grossier moyen. Elle est assez variable ; les côtes intérieures sont le plus ordinairement au nombre de huit, mais elles varient de sept à onze. Dans les individus d'Aizy et de Laon, qui sont aussi les plus grands, les côtes intérieures sont souvent d'un brun noirâtre, ce qui les rend plus apparentes. Dans les individus les plus frais, la surface extérieure, recouverte d'une mince couche corticale subcornée, est d'un gris peu foncé.

"Nos plus grands individus ont jusqu'à 9 millimètres de diamèter."

"*Localités.*—Aizy, Laon, Chaumont, Brasles, Fontenay—Saint-Père, Parnes."

Although Deshayes says the interior ribs extend "du summit à la base," the figures in Dixon's work show that such is not always the case, they neither reach the base nor the umbonal region. Dixon gives no description but his figures indicate some slight external striation and color patches.

In general we feel great hesitation in assigning specimens from both sides of the Atlantic to the same species. But in this case Dixon's figures represent the American form so precisely that it would seem absurd to propose for it a new name. That Aldrich's *Pecten alabamensis* is a precursor of this and should be reckoned as a subspecies only, will probably be shown hereafter. The main points of difference between this and *A. alabamense* are: 1st. In *squamulum* from Woods bluff there are normally 9 ribs, exceptions are rare; the exterior of *squamulum* is smooth except sometimes the left valve is finely striate radially; the right valve of *alabamense* is finely, sharply, striate concentrically and is superimposed generally by very strong, sharply defined raised lines or costæ which cause nodulations at their intersection with the stronger concentric lines; the curvature of the valves of *alabamense* is uniform; in *squamulum* there is a slight flattening anteriorly and posteriorly just below the umbonal ridge, and there are yellowish color patches scattered about over the left valve. Cossmann has with propriety referred Lamarck's *P. squamula* to *Amussium* (Extr. Ann. Soc. Roy. Mal. de Belg., vol. xxxi, 1896, App. 2, p. 63). It is slightly gaping fore and aft, has strong interior ribs, is practically smooth exteriorly, and has internally slight projections on the lower portions of the ridges formed by the ears. It may be observed, however, that the ears of this species are rather large for *Amussium* and that there is a decided slit beneath the anterior ear of the right valve for the passage of a byssus. This feature together with the strong markings of *A. alabamense* Ald. show that the limits of the genus *Amussium* must be somewhat enlarged.

Locality.—Alabama: Woods Bluff.

Specimens figured.—Woods Bluff. Paleont. Mus., Cornell University.

Chlamys greggi, n. sp. Pl. 7, figs. 4, 5.

Syn. ? *P. deshayeii* Ald., Bull. No. 1, Geol. Surv. Ala., p. 57, 1886.

Specific characteristics.—General appearance as figured; exterior with about 25 to 30 strong, smooth, sharply defined ribs radiating from the beak without bifurcation, ears with 5 or 6 radiating folds or costæ; interspaces about twice the breadth of the ribs, anteriorly and posteriorly showing the microscopic ex-curving striæ of *Camptonectes*

This species is of nearly the form and size of *C. choctavensis*, from which it is distinguished by its small number of ribs, its lack of costal bifurcation and imbrication, and the presence of *Camptonectes* structure in the interspaces.

Right valves of this species are somewhat gibbous.

Localities.—Alabama: Yellow Bluff; Gregg's Landing; Bell's Landing; Lower Peach Tree Landing. Georgia: Ft. Gaines.

Type.—Gregg's Landing, Harris' collection.

Chlamys choctavensis, Pl. 7, fig. 6.

Syn. *P. choctavensis* Ald., Bull. Amer. Paleont., vol.i, p. 68, pl. 6, fig. 7, 1895.

Aldrich's original description.—Loco citato.

Localities.—Alabama: Choctaw Corner and Woods bluff.

Specimen figured.—Woods Bluff; Paleont. Museum, Cornell University.

Avicula, sp. Pl. 7, fig. 7, a.

Syn. *A. limula* Ald., Bull. 1, Geol. Surv. Ala., p. 54, 1886.

It is quite possible that this is *A. limula* Con., but its state of preservation is not sufficient to warrant specific identification.

Locality.—Alabama: Woods Bluff.

Specimen figured.—Paleont. Museum, Cornell University.

Pinna, sp. Pl. 7, fig. 8.

Syn. *Pinna* sp. Ald., Bull. 1, Geol. Surv. Ala., p. 54, 1886.

It is difficult to give the dimensions of this species though the general form can be made out from the fragmentary specimen figured. The markings on the upper moiety of the valve resemble those of *P. argentea* Con., but the lower portion does not show the rugose lines of that species. This resembles more closely the Miocene form from Patuxent River, Md.

Locality.—Alabama: Woods Bluff.

Specimen figured.—Woods Bluff; Paleont. Museum, Cornell University.

Modiola alabamensis, Pl. 7, fig. 9.

Syn. *M. alabamensis* Ald., Bull. Amer. Paleont., vol. i, p. 68, pl. 6, fig. 13.

Aldrich's original description.—Op. cit.

The original specimen shows no radiate marking beneath a line drawn from the umbo to the posterior basal margin, except at the extreme anterior. Our specimen, a right valve shows not only the markings of the type but also fine radii where the latter is smooth.

Localities.—Alabama : Woods Bluff ; Choctaw Corner.

Type.—Choctaw Corner ; Aldrich's collection.

Specimen figured.—Woods Bluff ; Paleont. Museum, Cornell University.

Arca hatchetigbeensis, n. sp. Pl. 7, fig. 10, a.

Syn. *Arca subprotracta* Ald., Bull. 1, Geol. Surv. Ala., p. 50, 1886.

Specific characterization.—Size and general form as indicated by the figure ; surface covered by well defined but somewhat irregular imbricate concentric lines, crossed by raised radiating fine costæ ; young shell not extremely elongate, with surface marking of equal strength everywhere ; in adults the medial sinus becomes more pronounced, the radiating ribs before the sinus being stronger than those behind the same, and the shell is more or less distorted.

This species differs from *protracta* Con.—*subprotractra* Heilp. by its much less elongate form, broader anterior, the presence of two particularly strong costæ located medially on the post-umbonal slope. By examining the type specimen of *A. protractra* in the Academy's collection at Philadelphia, it will be seen that it agrees somewhat more nearly with this species than would be supposed from Conrad's figure, yet the agreement can scarcely constitute specific identity.

Locality (Lignitic).—Alabama : Hatchetigbee.

Type.—Hatchetigbee ; Paleont. Museum, Cornell University.

Barbatia cuculloides, var. Pl. 8, fig. 1, a.

Syn. *Arca cuculloides* Con., Foss. Shells, Tert. Form, p. 37, 1883.
Arca lima var. Ald., Bull. 1, Geol. Surv. Ala., p. 57, 1886.
Arca sp. Harris, Bull. Amer. Paleont., vol. 1, p. 164, pl. 13, figs. 8, 6, 9, a., 1896.

Conrad's original description.—"Shell compressed, thick, inequivalve, reticulated; with a broad subcentral sinus, passing from the beak to the basal margin; posterior side elongated, strongly ribbed, and carinated; anterior side with numerous striæ; anterior end truncated. Length 2¼ inches. Breadth 1½ inches.

"The hinge of this shell approaches *Cucullæa* in the interval between the beaks, having arcuated grooves under the beak; line of series of hinge teeth widely interrupted, and transverse at the extremities." Locality; Claiborne, Alabama.

The variety has a somewhat more pointed posterior basal angle and has somewhat more sharply defined sculpturing than the type specimen, especially on the post-umbonal slope. Yet they seem scarcely distinct specifically.

Type.—Academy Natural Sciences, Philadelphia.

Localities (Lignitic).—Alabama: Gregg's Landing. Bell's Landing,—Aldrich. Georgia: Ft. Gaines, ledge 50 feet below top of cliff, i.e. bed 8; see. p. 33.

Specimen figured.—Gregg's Landing. Paleont. Museum, Cornell University.

Trigonarca pulchra, var. Pl. 8, figs. 2, a.

Syn. *Nœtia pulchra* Gabb. Jr., Acad. Nat. Sci. Phila., vol. 4, p. 388, pl. 67, fig. 55, 1860.
Limopsis pulchra Heilp., Proc. Acad. Nat. Sci., 1890, p. 403.

Gabb's original description.—"Subquadrangular; beaks small, incurved; umbonal slope nearly straight; anterior margin rounded, basal arcuate; posterior subangular; surface marked by numerous radiating and transverse lines; edge crenate within; posterior muscular scar subtriangular, anterior subrhomboidal.

"*Dimensions.*—Length .27 in., width .35 in."

The variety in hand is much smaller than the typical specimen from Texas and the radiating lines are far less distinct; yet the general form is the same—quite unlike the Claiborne and Lower Claiborne species of Alabama.

Lignitic Locality.—Alabama: Woods Bluff, Hatchetigbee.

Specimen figured.—Woods Bluff; Paleont. Museum, Cornell University.

Cucullæa gigantea, var. Pl. 8, figs. 3, a. 4.

Syn. *C. transversa* Ald., Bull. 1, Geol. Surv. Ala., p. 40, pl. 4, figs. 11, 11a, and p. 57, 1886.
C. transversa Har., Amer. Jour. Sci., vol. 47, p. 302, 1894.

The original description of *C. gigantea* Con., in the Jour. Acad. Nat. Sci. Phila., vol. vi, p. 227, pl. 10 fig. 4, 1830, was drawn from the very imperfectly preserved large casts in the vicinity of Ft. Washington, Md. and hence gives but little definite knowledge regarding the specific features of this fossil. For the sake of completeness however, the description is here repeated.

Conrad's original description.—"Shell subtriangular, obliquely cordate; very ventricose, with numerous longitudinal sulci; anterior side flattened, produced and subcuneiform; posterior side very short; umbones gibbous; beaks distant, and much incurved.

"Three and three-quarters inches in length; and five and a quarter inches in breadth." "Cabinet of the Academy."

Early in 1894 the writer pointed out the probable equivalency of the Alabama forms with the *C. gigantea.* Sufficient material however, was not at hand to warrant uniting them without reserve. During last summer's work along the Rappahannock and Potomac this species was specially sought after; and by examining the collections with some care it is apparent that there is but one species of *Cucullæa* in the Virginia Eocene, i.e. that *gigantea*, *ononchela*, *idonea*, and *transversa* are in all probability the same.

This southern form which for various reasons Aldrich and the writer have referred to *transversa* does vary somewhat from the Virginia specimens, but scarcely enough to call another species.

This matter will be more carefully discussed in a future publication on the Eocene of Maryland and Virginia.

Localities. — Alabama: Gregg's Landing, Bell's Landing.
Georgia: Ft. Gaines, bed 8; see. p. 33.

Type.—Academy Natural Sciences, Philadelphia.

Specimens figured.—Gregg's Landing, Harris' collection.

Pectunculus idoneus, Pl. 8, figs. 5, a. 6.

Syn. *P. idoneus* Con., Foss. Sh., Tert. Form, p. 39, 1833.
Pectunculus (n. sp.) Tuomey, 2d Biennial Rep't, p. 271, 1858.

P. stamineus Ald., Bull. 1, Geol. Surv. Ala., pp. 50, 53, 57, 58, 1886.
Pectunculus sp., Harris, Bull. Amer. Paleont., vol. 1, p. 167.

Conrad's original description.—"Shell suborbicular, thick, convex; oblique, with rather obscure radiating striæ, and minute intervening lines; umbo convex, beaks distant, rather prominent and pointed; cardinal teeth large; truncated in the center by a rectilinear line; cavity capacious; margin crenate. Length 1¼ in." Conrad's specimen was from Claiborne, Ala.

Grave doubt is felt as to the exact equivalency of all the Lignitic specimens with this species. Yet there seem to be no fixed or constant differences upon which to found a new species.

Localities. — Alabama: Nanafalia; Tuscahoma Landing; Hatchetigbee; Gregg's Landing; Bell's Landing, four miles above Hamilton Bluff. Georgia: Ft. Gaines; bed 8, p. 33.

Type.—Academy Natural Sciences, Philadelphia.

Specimens figured.—Fig. 5, Yellow Bluff; C. U. collection. Fig. 6, Gregg's Landing; Harris' collection.

Nucula ovula, Pl. 8, fig. 7.

Syn. See vol. 1, Bull. Amer. Paleont., p. 168.

Localities.—Alabama: Woods Bluff; Nanafalia; Gregg's Landing; Choctaw Corner; four miles above Hamilton Bluff, Alabama River.

Specimen figured.—Woods Bluff; Paleont. Museum, Cornell University

Nucula magnifica Con.

Aldrich reports this species from Bell's and Gregg's landings, Alabama, but our collections contain no specimens from these or other Lignitic localities.

Leda elongatoidea, Pl. 8, figs. 8, 9.

Syn. *L. elongatoidea* Ald., Bull. Amer. Paleont., vol. i, p. 69, pl. 6, fig. 2, 1895.
Non L. elongatoidea? Har., Bull. Amer. Paleont., vol. i, p. 169, pl. 14, fig. 10.

Aldrich's original description. Op. cit. p. 69.

Aldrich's type specimen is slightly broken anteriorly and posteriorly, but agrees well with the specimens in our collections. Among the latter however, several specimens show a few high concentric lines about the umbo.

Fig 9 is a strangely elongated variety from Gregg's landing, it presents no essential varietal features however, except its extreme posterior prolongation.

Localities. — Alabama : Butler ; Woods Bluff ; Nanafalia ;
Ozark.

Type.—Aldrich's collection.

Specimen figured.— Paleontological Museum, Cornell University.

Leda corpulentoides, var's. Pl. 8, figs. 10, 11.

Syn. *Yoldia corpulentoides* Ald., Bull. Amer. Paleont., vol. i, p. 70, figs. 9, 9a., 1895.

Aldrich's original description.—Op. cit. p. 70.

Mr. Aldrich very kindly sent us several duplicate specimens of *corpulentoides* from Tuscahoma, but they are all in a very imperfect state of preservation. Our own collections contain the specimens figured, presumably belonging to this species. Fig. 10 is from Gregg's landing, is quite tumid centrally and is almost devoid of surface sculpture except traces of fine concentric lines. It is, however, accompanied by younger forms showing stronger concentric lines centrally, which diminish in strength anteriorly and which when arriving at about the longitude of the posterior channel in Fig. 11, suddenly terminate in a slightly enlarged granule ; this feature is clearly noticeable near the beaks only. The *corpulentoides* from Tuscahoma are all adults, and are somewhat stouter than the Gregg's landing specimens, but it seems probable that all will eventually prove to be identical.

Fig. 11 is from Nanafalia and agrees fairly well with *corpulentoides*, except the channel just anterior to the umbonal slope is very deep, the concentric lines are coarser, and the general form of the shell is somewhat less inflated than *elongatoides*.

Type.—Aldrich's collection.

Specimens figured. — Paleontological Museum, Cornell University.

Leda marieana. Pl. 8, fig. 12.

Syn. *L. marieana* Ald., Bull. Amer. Paleont., vol. ii, p. 182, pl. 6, fig. 5.

For Aldrich's original description, *op. cit.*

Without the type specimen before us we are very much inclined to regard this as the young of fig. 13, pl. 8.

Localities.—Alabama: Choctaw Corner.

Type.—Aldrich's collection.

Leda protexta. Pl. 8, fig. 13.

Syn. *Nuculana protexta* Con., Amer. Jour. Conch., vol. i, 1865, p. 147, pl. 11, fig. 6.
Leda protexta Heilp., Proc. Acad. Nat. Sci. Phila., 1880, p. 365.
Leda protexta Ald., Bull. 1, Geol. Surv. Ala., pp. 50, 53, 57, 1886.

Conrad's original description. — "Elongated, slightly ventricose, with closely arranged, minute thread-like concentric lines, distinct and rugose on the anterior submargin, which is flattened, or broadly and slightly furrowed. Upper margin oblique, medially rectilinear, reflexed at the end; posterior extremity above the middle and on a line with the anterior end; posterior ventral margin obliquely truncated.

"*Locality.*—Alabama. Dr. Showalter."

This species shows considerable variation in outline and surface ornamentation. Older Lignitic specimens, from Gregg's landing show finer striæ and less sharply defined post-umbonal slope.

We are well aware that Gnbb gave the name *protexta* to a species (*L. protexta* Gabb, Jour. Acad. Nat. Sci., Phila., vol. iv, 1860, p. 303) five years before Conrad named this form. Since Mr. Stanton, our best authority on invertebrate Cretaceous paleontology, writes that Gabb's species just referred to is a true *Leda*, it follows as a matter of course that the same specific name cannot be permanently retained for the Lignitic form under discussion.

The indications are however, that when all the Eocene stages have been carefully gone over, this *L. protexta* Con. will prove but an ancestral form of a species named by Conrad himself several years before 1865. Hence, feeling that the name *protexta* is doing less harm in Tertiary literature than a new and perhaps unnecessary name might do, the latter is avoided for the present.

Localities.—Alabama: Woods Bluff; four miles above Hamilton Bluff, Alabama River; Ozark; Gregg's Landing. Georgia: Ft. Gaines.

Type.—Acad. Nat. Sci., Phila.; improperly labelled by Heilprin "Claiborne, Ala."

Leda parva, Pl. 8, fig. 14.

Syn. *Nucula parva* Rogers, Trans. Amer. Philos. Soc,, vol. v, p. 340, 1838.
Leda n. sp. Ald., Bull. 1, Geol. Surv. Ala., p. 53, 1886.
Leda robusta Ald., Bull. Amer. Paleont., vol. i, p. 69, pl. 6, figs. 1, 1a.

Rogers' original description.—"Shell ovate, inflated, rounded before, not much produced, but rapidly tapering to a truncated point behind, furnished with about twelve rather coarse concentric folds or ridges, and a longitudinal gently depressed groove or undulation of surface, running from near the beak to near the posterior basal margin ; beaks nearly central ; anterior series of teeth slightly arched ; posterior series nearly straight ; margin entire ; cavity rather deep. Length, three-twentieths ; height, two-twentieths of an inch." Coggin's Pt., Pr. Geo. Co., Va.

This species shows great variation as regards size and surface ornamentation. The specimen figured by Aldrich (*loc. cit.*) represents a marked variety showing very few concentric plications. At Gregg's landing a somewhat larger form occurs, showing not the broad concentric folds of Aldrich's figure, but a great many rounded, concentric lines. This in turn is preceded by the form styled by us last year, *Leda quercollis* (Bull. Amer. Paleont., vol. 1, p. 169.)

Specimens from Evergreen, Va., show characters precisely like the smaller, less robust specimens from Woods bluff.

Localities (Gulf States).—Alabama : Woods Bluff ; 1¼ miles w. s. w. of Choctaw Corner ; Gregg's Landing ; 4 miles above Hamilton Bluff, Alabama River.

Type.—

Specimen figured.—Woods Bluff ; Paleont. Museum, Cornell University.

Yoldia aldrichiana, Pl. 8, fig. 15.

Syn. *Leda elongatoidea ?* Har. (non Ald.,) Bull. Amer. Paleont., vol. i, pl. 14, fig. 10.

Aldrich's *elongatoidea* having proven quite a different shell, we venture to describe this species as new.

Specific characterization.—Size and general form as indicated by the figure ; anterior sub-basal margin tending to become rectilinear ; shell rather thin and *Yoldia*-like, transversed exteriorly by very minute concentric lines on the median portion, dying away anteriorly and posteriorly; anterior series of teeth slightly curved; posterior series nearly rectilinear causing the margin of the shell half way from beak to posterior extremity to be slightly elevated; pallial sinus deep; a slightly depressed area extending from the beak to the posterior basal and superior margin.

The Midway specimens are varietally distinct from the Lignitic.

Localities.—Alabama: Woods Bluff.

Type.—Woods Bluff; Paleont. Museum, Cornell University.

Venericardia planicosta, Pl's. 9, & 10.

Syn. See Bull. Amer. Paleont., vol. i, p. 172; add:—
Cardita densata Con., Jour. Acad. Nat. Sci. Phila., vol. i, p. 130, pl. 14, fig. 24, 1848.
Cardita planicosta Tuomey, 1st Biennial Rep't Geol. Ala., pp. 146–147, 1850.
Cardita planicosta Tuomey, 2d Biennial Rep't Geol. Ala., p. 270, 1858.
Venericardia planicosta Con. (Heilp.), Proc. Acad. Nat. Sci., Phila., 1880, p. 366, foot-note.
Venericardia planicosta Ald., Bull. 1, Geol. Surv. Ala., pp. 50, 53, 55, 57, & 58, 1886.
Venericardia planicosta Smith & Johnson, Bull. 43, U. S. Geol. Surv., pp. 40, 44, 45, 50, & 51, 1887.

Lamarck's original description.—See Bull. Amer. Paleont., vol. i, p. 172, 1896.

It has already been shown how great are the variations of this species in the oldest Eocene or Midway stage. In the Lignitic a vast number of variations have been noticed, but to describe them in detail would require a great number of plates and several hundred pages of text. The subject will here be dismissed with simply the following remarks.

Form α. This is sub-circular in outline with the exception of the beak, and is remarkable for its paucity of ribs. These are about twenty-three in number, and near the umbo are narrower than the interspaces; in the center of the shell ribs and interspaces are of about equal width; near the base margins the ribs increase rapidly in width and in some specimens coalesce. Localities for this form are Nanafalia (occasionally) at the base of the Lignitic, and four miles above Hamilton bluff on the Alabama river, near the summit of the Lignitic.

Form *β*. A large somewhat triangular variety of 28 or 30 costæ, with a tendency to become nasute posteriorly. These features are shown to some extent in pl. 9, fig. 1. It will be observed that on the greater portion of the surface the ribs are far wider than their interspaces. In the center of each rib there is often a trace of an interrupted, raised, radiating line. Hinge, powerful. Typical localities, Gregg's landing, Bell's landing, occasionally at Yellow bluff.

Form *γ*. A large heart-shaped variety of about 20-22 ribs, distinct near the umbo, but quickly becoming reduced to very faint undulations on a comparatively smooth surface. This form is shown by figs. 1-4, pl. 10. It is fairly abundant at Woods bluff and Ozark, and in the Lower Claiborne at Lisbon. Specimens from 1¼ miles w. s. w. of Choctaw corner, combine the outline of *β*. with the surface of *γ*.

Form *δ*. This is the form found in such great profusion at Hatchetigbee bluff. Of all American specimens this seems most nearly related to the *V. planicosta* of Bracklesham bay and the Calcaire grossier in general. A specimen from Woods bluff showing most of the features of this form is shown on plate 10, fig. 5. The ribs, about 30 in number, are obsolescent on the lower moiety of the shell. There is here a tendency to show a slight straightening or truncation of the anterior sub-margin, a feature so noticeable in specimens from the Calcaire grossier horizon of Europe, and one that generally serves to distinguish at once foreign from American specimens. A small specimen of this variety has been described and figured by Conrad under the name of *Cardita densata*, Jour. Acad. Nat. Sci. Phila., vol. i, pl. 14, fig. 24.

Lignitic localities.—Alabama: Nanafalia; Tuscahoma; Woods Bluff; 1¼ miles w. s. w. of Choctaw Corner; Yellow Bluff; Gregg's and Bell's Landings, four miles above Hamilton Bluff; Ozark. Georgia: Ft. Gaines.

Specimens figured.—Pl. 9, fig. 1, Bell's Landing; Harris collection. Fig. 2 and fig. 3, Woods Bluff, C. U. collection; p. 130, pl. 10, Woods Bluff, Paleont. Museum, Cornell University.

Venericardia alticostata, var. Pl. 11, fig. 1.

Syn. See Bull. Amer. Paleont., vol. i, p. 171, 1896; add:—
Cardita decusata Tuomey, 2d Biennial Rep't, p. 271, 1858.

V. rotunda var. Ald., Bull. 1, Geol. Surv. Ala., p. 57, 1887.

Conrad's original description. — See Bull. Amer. Paleont. as above. The general form of this variety is certainly that of *V. rotunda* Lea, but the costation is different, in fact very similar to *alticostata*, i. e. towards the anterior the exterior crenulated portion of each rib is superimposed on a broader base, which in turn is sometimes on a second base and the latter upon the shell itself. This form is found at Gregg's landing, Lower Peach Tree, and perhaps at Nanafalia.

Smaller, but more nearly typical specimens of this species are found in abundance in the upper Lignitic at Woods bluff and Ozark, Ala.

Specimens figured.—Gregg's Landing; Paleont. Museum, Cornell University.

Astarte smithvillensis, var. Pl. 11, fig. 2.

Syn. *A. conradi* Buckley, 1st Bull. Ann'l Rep't Geol. Surv. Tex., p. 63, 1874.
Crassatella alta (young) Heilp., Cont. to Geol., p. 38, 1884.
Astarte nicklensii Ald., Bull. 1, Geol. Surv. Ala., pp. 50–53, 1886.
Astarte tellinoides Ald., Bull. 1, Geol. Surv. Ala., p. 53, 1886.
Astarte tellinoides Heilp., Proc. Acad. Nat. Sci. Phila., 1890 p. 402.
Astarte smithvillensis var. Har., Proc. Acad. Nat. Sci. Phila., 1886, p. 475, pl. 20, fig. 6.
A. smithvillensis Har., Proc. Acad. Nat. Sci. Phila., 1895, p. 48, pl. 1, figs. 8, a, 9, a, b, c.

Harris' original description.—"Size and general form as indicated by the figures; surface in typical specimens marked by strong concentric rugæ, especially towards the base; these slope gently above but abruptly below and are superimposed by fine striæ; umbones flattened.

"This species shows great variations in form and size as well as markings. At Collier's Ferry some specimens are more elongated, others more rotund; some have crenulations on the anterior sub-margin while others are smooth." Typical locality and horizon, Smithville, Texas. Lower Claiborne.

Localities (Lignitic).—Woods Bluff and Ozark, Ala.

Type.—Texas State Museum.

Specimen figured.—Woods Bluff, Lea Memorial collection in Acad. Nat. Sci., Phila.

Crassatella tumidula, Pl. 11, figs. 3, 4.

Syn. *Crassatella alta* Tuomey, 2d Biennial Rep't, p. 271, 1858.
C. tumidula Whitf., Amer. Jour. Conch., vol. i, p. 267, 1865.
C. tumidula Ald., Bull. 1, Geol. Surv. Ala., p. 57, 1886.

Whitfield's original description.—"Shell sub-triangular or subclavate in outline; anterior end broadly rounded; posterior end narrow, acute; valves ventricose in front, attenuated behind, with a shallow sulcus in front of the umbonal slope; surface smooth, except rugose markings on the umbones; hinge teeth moderately large; lateral tooth elongate, linear; ligamental area shallow, broad-triangular; muscular scars large; anterior subreniform; posterior circular; margin of shell finely crenulate on the anterior and antero-basal portions.

"Closely resembles *C. petropsis* Gabb, a Cretaceous species.

"*Locality.*—Six miles above Claiborne, Alabama, west side of the river."

The locality designated is doubtless Gregg's landing.

Whitfield's specimen was small but the description is such as to determine the species beyond a doubt.

Localities.—Gregg's Landing; Bell's Landing, and Yellow Bluff, on the Alabama River.

Type.—Hall's collection.

Specimens figured.—Yellow Bluff; Paleont. Museum, Cornell University.

Crassatella halei, n. sp. Pl. 11, fig. 5.

Syn. *Crassatalla mississippiensis* Tuomey, 2d Biennial Rep't p. 271, 1858.
? *Crassatella* sp. Ald., Bull. 1, Geol. Surv. Ala., p. 57, 1886.

Specific characterization.—Size and general form as indicated by the figure; roughly quadrangular and with coarse concentric lirations while young, becoming rapidly smoother with additional increments of growth until near the basal margin in the adult state the surface is again more or less rugose; basal margin very arcuate; posterior truncate; post-umbonal slope broad with often a faint longitudinal medial depression; large tooth in right valve set much more obliquely than in the preceding species; margin may be either crenate or not crenate.

Named in honor of C. S. Hale, who first investigated and described the Lignitic beds of Alabama.

Localities.—Alabama: Nanafalia (a varietal form); Yellow Bluff; Gregg's Landing. Georgia: Ft. Gaines.

Type. — Gregg's Landing; Paleontological Museum, Cornell University.

Crassatella producta, Con.

This Aldrich cites from Hatchetigbee bluff, Bull. 1, Geol. Surv. Ala., p. 50, 1886, but our collections from that locality do not contain it.

"Kellia" prima, Pl. 11, figs. 6, a.

Syn. *K. prima* Ald., Bull. Amer. Paleont., vol. ii, p. 181, pl. 6, figs. 3,a.

Aldrich's original description.—See p. 181 of this volume.

We are under the impression that this species should be referred to another genus, but having no good specimens at hand it has seemed best to designate it as above for the present.

Localities.—Texas: Sabinetown. Alabama: Choctaw Corner.

Type.—Choctaw Corner; Aldrich's collection.

"Fabella" oblonga, Pl. 11, figs. 7, 8,

We have no specimen of this species. See Bull. Amer. Paleont., vol. ii, p. 182, pl. 6, fig. 2.

Locality.—Choctaw Corner.

Type.—Aldrich's collection.

"Scintilla" clarkeana, Pl. 11, fig. 9.

We have no specimens of this species. See Bull. Amer. Paleont., vol. ii, p. 182, pl. 6, fig. 8.

Locality.—Choctaw Corner.

Type.—Aldrich's collection.

Protocardia lenis var. Pl. 12, fig. 1.

Syn. *Cardium* (*Protocardia*) *lene* Con., Proc. Acad. Nat. Sci. Phila., 1855, p. 258.
Cardium nicoleti Tuomey, 2d Biennial Rep't, p. 271. 1858.
Protocardia virginiana Con., Proc. Acad. Nat. Sci, Phila., 1864, p. 211.
Cardium (*Protocardia*) sp. Heilp., Proc. Acad. Nat. Sci. Phila., 1880, p. 365.
Protocardia nicolleti Ald., Bull. 1, Geol. Surv. Ala., pp. 53, 57, 1886.

Protocardia virginiana? Har., Proc. Acad. Nat. Sci. Phila. 1896, p. 475, pl. 20, figs. 7, 8.

Conrad first refers to the typical form of *lenis* as follows:

" A species of *Cardium* very nearly allied to this [*P. nicolletti*], I formerly believed to be the same ; but it accompanies a different group, and presents variations entitling it to be a specific distinction.

" It is from Pamunkey river, Va.

"Compared with *C. nicolletti* ; umbo less inflated, posterior margin oblique, shell proportionally longer, and the radiating lines 22 ; in the other 25. The posterior cardinal tooth larger, &c. It may be named *C. lene.*"

In 1864 Conrad evidently forgot that he had already named this species and accordingly described and named it this time as *Protocardia virginiana.* He gives the same locality, Pamunkey river, and remarks that "the species is smaller and proportionally longer than *P. nicolletti* with a smaller umbo. "Also "height 1½ in.; length 1 2-5 in."

The variety from the Lignitic of Alabama is much smaller than the Virginian type. Yet it seems somewhat more nearly related to the latter than to *nicolletti*, but all may prove one and the same. From *nicolletti* it differs not only in its smaller size, but, as stated a year ago, by its smaller umbones, and also by the fact that the area with radiating lines not only occupies the post-umbonal slope, but has 8 or 10 lines on the lateral area of the shell.

Localities.—Alabama: Woods bluff; Gregg's Landing; Bell's Landing; Ozark; four miles above Hamilton Bluff, Alabama River.

Cardium hatchetigbeense, Pl. 12, figs. 2, a.

Syn. *Cardium hatchetigbeense* Ald., Bull. 1, Geol. Surv. Ala., 1886, p. 39. pl. 4, figs. 12, a, b.

Aldrich's original description.—"Shell large, subquadrate, ventricose with about thirty-two ribs; ribs flattened oval, with the scars of spines visible along their center; a few coarse, flattened, triangular spines remaining on the posterior and anterior, largest on the posterior, which is sub-truncate, the largest rib forming the angle; marginal serrature largest at the angle. The flattened spaces between the ribs are equal in width to the ribs and nearly smooth, showing faintly the lines of growth. Cardinal teeth in the left valve double, the lower one the largest, very strong and erect.

"*Locality.*—Hatchetigbee Bluff, Ala."

Type.—Hatchetigbee Bluff, Aldrich's collection.

Specimens figured.—Hatchetigbee Bluff, Aldrich's collection.

Cardium hatchetigbeense? Pl. 12, fig. 3.

This specimen from Sabinetown, at first seemed quite different from *hatchetigbeense*, since it is nearly double the dimensions of the latter, the spaces between the ribs are often sharply striate transversely, and the ribs are regularly pitted where spines have been dislodged. These spines must have been very large on the posterior slope. By carefully examining Aldrich's types their pits can be found in certain places. The size of this shell reminds one at once of *C. harrisi* Vaughan, but by placing the type of the latter by the side of this specimen, many distinguishing characters appear.

Cardium tuomeyi, Pl. 12, fig. 4.

Syn. *Cardium vicksburgense* Tuomey, 2d Biennial Rep't, p. 269, 1858.
Cardium tuomeyi Ald., Bull. 1, Geol. Surv. Ala., Ald., 1886, p. 40, pl. 4, figs. 13, a.

Aldrich's original description.—"Shell ovate, thick through the umbones; ribs numerous, about forty-four in number, flattened above and indented with scars of spines; spaces between the ribs much smaller than the ribs themselves; a few small, scattered spines near the beaks, which are central and raised; muscular scars strongly marked.

"*Locality.*—Nanafalia, Ala.

"Differs from the previous species described by its more numerous ribs, more rounded form, smaller spines and thicker shell."

Casts indicate that this species grew to a fairly large size in the vicinity of Ft. Gaines, Ga.

Type.—Aldrich's collection.

Specimens figured.—Paleont. Museum, Cornell University.

Coralliophaga prima n. sp. Pl, 13, figs. 4, 5.

Specific characteristics.—Size and general form variable, the adult elongate form being shown by the figures; surface with concentric lines about the umbones, becoming rugose and lamellar posteriorly; teeth sometimes becoming obsolete in old specimens but when well preserved showing in the left valve one strong, nearly horizontal cardinal tooth, with a deep pit on either side; right valve with two cardinal teeth as shown in the figure; pallial sinus not deep but well defined; numerous traces of radiating striæ.

The dentition of this species seems to be precisely that of *C. lithophagella* Lam., neither have any lateral teeth worthy of the name. On the other hand the pallial sinus is far too deep for this genus, and approaches that of *Petricola*. The radiating striæ also recall the latter genus. That it was a boring shell, I have no doubt.

Locality. — Alabama: Found abundantly in the indurated, bluish, fossiliferous, thin ledges in Hatchetigbee Bluff. A fragment of a very large specimen, probably of this species, is in Harris' collection from Gregg's Landing.

Type.—Paleontological Museum, Cornell University.

Meretrix nuttalliopsis, Pl. 12, fig. 5.

Syn. *Cytherea nuttalliopsis* Heilp., Proc. Acad. Nat. Sci. Phila., 1880, p. 370, pl. 20, fig. 1.
C. nuttalliopsis Ald., Bull. 1, Geol. Surv. Ala., pp. 53-57.
? C. mimina Ald., Bull. 1, Geol. Surv. Ala., pp. 53-57.

Heilprin's original description.—"Shell sub-elliptical, moderately ventricose, its surface covered with fine concentric striæ, which are apt to become roughly imbricate on the basal margin; umbones not very prominent, rather anterior; lunule cordate, deeply impressed at about its middle, its outline clearly pronounced by a sharply impressed line; posterior extremity regularly rounded, the anterior somewhat produced; margin entire; pallial sinus somewhat angular, pointing towards the center of the shell.

"Length, 1½ inch. Knight's Branch, Charke Co., Ala.

"This species most resembles among American species of *Cytherea* the *C. nuttalli* Con., from which it may be distinguished by the greater production forward of the anterior extremity, and by the median depression in the lunule. In this last character it agrees with *C. poulsoni* Con., from which, however, it very materially differs in form, and in the much less development of the umbones."

The nomenclature of the lower Eocene *Meretrices* is still in an extremely unsettled state. Specimens of this species from Woods bluff are extremely abundant, well preserved and typical in form. Those from the mouth of Bashi creek and Ozark are still quite typical though somewhat smaller than at Woods bluff and sometimes tending to be a little more triangular in outline. The same remark applies to those from four miles above Hamilton bluff on the Alabama.

Variety **greggi** n. var. Pl. 13, figs. 1, 2.

Syn. *Meretrix nuttalliopsis* Har., Proc. Acad. Nat. Sci. Phila., 1896, pl. 22, figs. 1, 2. Erroneously written *M. mortoniopsis* l. c., p. 477.

Descending in the geologic scale to Bell's and Gregg's landings and Lower Peach Tree, somewhat wider variations are met with. The forms more rotund posteriorly, probably females (pl. 13, fig. 1) have a close resemblance to *nuttalliopsis*, while the specimens more pointed posteriorly, probably males, (pl. 13, fig. 2) would not at first sight be placed under this species.

Variety **fulva** n. var. Pl. 12, figs. 8–10.

At Yellow bluff on the Alabama, and at Ft. Gaines, Ga., a variety occurs still farther separated from the typical form. Here also two mutations are observable, probably owing to sex, one rounded posteriorly, the other more or less pointed. Fig. 10 shows the blunt form, young, fig. 9 the pointed form, young, fig. 8 an adult. This form is unusually developed anteriorly, and has a tendency to become inflated or bulged up along the umbonal ridge. The reason for not giving a new specific name to this marked variety is, that some of its phases are indistinguishable from certain forms of *greggi*, and the latter is certainly but a variety of *nuttalliopsis*. The intimate relationship, or perhaps specific identity of this species with *Meretrix riplyana* Gabb, will doubtless be satisfactorily proven. Likewise its identity with *M. ovata* Rogers, and other Virginian forms will probably be shown.

Type specimens figured.—Paleontological Museum, Cornell University.

Meretrix subimpressa var. Pl. 12, figs. 6, 7.

Syn. *C. subimpressa* Con., Jour. Acad. Nat. Sci. Phila., vol. i, p. 130, pl. 14, fig. 26.
C. perovata? Ald., Bull. 1, Geol. Surv. Ala., p. 53.

Conrad's original description. — "Ovate, slightly ventricose, smooth and polished, with concentric slightly impressed lines on the anterior side; anterior side short, rather acutely rounded; posterior side produced, acutely rounded at the extremity; dorsal margin long, oblique, slightly curved; beaks prominent; lunule lanceolate, defined by a slightly depressed line. Length, 1⅛ in. Height, .8 in. Locality: Marlbourne, Hanover county, Virginia. Mr. Ruffin.

"This species may be distinguished from *C. æquorea* by its greater comparative length, smaller size and wanting the strong furrows of that species. Mr. Ruffin obtained several entire specimens."

The variety here referred to has some resemblance to *M. pearlensis* Har., but has no indications of such markings. From *subimpressa* typical it differs in having its upper and basal margins more rectilnear, its posterior very prolonged, but finally abruptly truncated, its anterior more produced and circular, its beaks slightly more prominent. The moderately deep truncated pallial sinus is the same in both.

Many specimens are scarcely distinguishable from young *M. lævigata* Lam., though the beaks are always a little pronounced and there are no signs of radiating lines.

Locality.—Alabama: Woods Bluff.

Specimens figured.—Paleontological Museum, Cornell University.

Meretrix hatchetigbeensis. Pl. 12, figs. 11, 12.

Syn. *Cytherea hatchetigbeensis* Ald., Bull. 1, Geol. Surv. Ala., 1886, p. 39, pl. 4, fig. 1.

Aldrich's original description.—"Shell rather thick, inflated, sub-rotund, transversely striate—the different periods of growth marked by a dropping down of the concentric lamina, giving a ridge-like appearance; umbones swollen; beaks elevated; lateral tooth in left valve transverse, conical and strong; ligament short-curved; excavation of the pallial impression angular; margin of the shell entire, thickened in some specimens.

Locality.—Hatchetigbee Bluff, Ala., beneath the Buhrstone.

"Prof. A. Heilprin considers this shell a *C. discoidalis* Con., but that is described as having the inner margin crenulate, while this is smooth."

I think this can scarcely be placed under *M. discoidalis* Con. Repub. Conrad's Foss. Sh., Tert. Form, pl. 20, fig. 2. It is very common at Hatchetigbee but has not been noted elsewhere.

? Type.—Aldrich's collection.

Specimen figured. — Hatchetigbee Bluff, Paleont. Museum, Cornell University.

Dosiniopsis lenticularis, Pl. 12, fig. 13.

Syn. *Cytherea lenticularis* Rogers, Trans. Amer. Philos. Soc., vol. vi, p. 372, pl. 28, fig. 1, 1839.
Cytherea eversa Tuomey, 2d Biennial Rep't p. 271, 1858.
Dosiniopsis lenticularis Ald., Bull. 1, Geol. Surv. Ala., p. 57, 1886.
Dosiniopsis lenticularis Har., Amer. Jour. Sci. vol. 47, p. 302, 1894.

Rogers' original description.—"Shell large, depressed, discoidal rather thick, length nearly equal to the breadth; transversely striated; lunule long, ovate, obscurely defined by a very faint impressed line; umbones rather depressed; beaks small, hardly recurved; teeth straight, divergent; cavity of the shell not deep; margin entire. Diameter about two inches.

"Locality, eastern Virginia, in the Eocene, where it is a common species.

"*Remarks.*—From the extreme friability of this shell it has been impossible hitherto to procure a perfect specimen. It differs from all the *Cythereæ* of our American Eocene beds in its nearly orbicular form, and its slight degree of inflation. The insulated tooth of the right valve is long, straight, and not much elevated. The anterior cardinal tooth in the same valve is slightly bifid. The striæ upon the surface of the disc are almost obsolete, where decay has not removed the external laminæ. The small incurvation in the beaks distinguishes it from *C. poulsoni* of Conrad (*C. globosa* La.), to which species it bears some resemblance."

Localities (Gulf slope).—Alabama: Bell's Landing. Georgia: Ft. Gaines.

Type.—

Specimen figured.—Bell's Landing; Harris' collection.

Corbicula cornelliana n. sp. Pl. 13, fig. 3.

We have only a fragment of this interesting form, and, were it not of universal interest we would pass it by unnoticed, unnamed. But the discovery of this genus or one very closely allied to it, as indicated by the long, curved anterior lateral tooth and three cardinals, a brackish water type, in the upper Lignitic, seems worthy of special remark. External striation about the umbo indicates that the shell when entire is more or less triangular in outline with angles very obtusely rounded, and sides curving, especially the base. It is quite gibbous. The right valve here figured show the long groove or socket for the anterior lateral of the left valve. A cavity below and behind the umbo is formed, as in *Dosinia*, by the decaying of soft shelly matter.

Locality.--Alabama: Hatchetigbee Bluff.

Specimen figured. — Paleontological Museum, Cornell University.

Psammobia ozarkana n. sp. Pl. 12, fig. 14; pl. 13, fig. 8.

Specific charactization.—General form of the shell as figured ; when young, anterior slightly longer than posterior, narrowing rapidly towards anterio-basal margin, posterior broadening, slightly truncated on the posterior-dorsal margin ; surface irregularly striate concentrically, slightly depressed from beak to base, with two or three obscure radiating folds extending from beak to basal margin just anterior to the posterior-basal margin.

Resembles *P. eborea* Con. somewhat, but has not the extended posterior of that species, the general form of the shell is not so elongate and the anterior cardinal tooth is not so large and well developed.

Locality.—Alabama : Ozark.

Type.—Paleontological Museum, Cornell University.

Sphærella sp. Pl. 13, fig. 6.

This specimen is very probably a varietal form of our *S. anteproducta* from Texas (Proc. Acad. Nat. Sci., Phila., 1895, p. 50, pl. 2, fig. 4), but since it is the only specimen in our collection from Hatchetigbee bluff, it seems best to postpone its identification until more material is obtained.

Diplodonta sp. Pl. 13, fig. 7.

This, and many fragments of larger specimens were found at Woods bluff. We await a more thorough investigation of the Maryland and Virginia Eocene before identifying the form specifically.

Solen sp. Pl. 13, fig. 9.

This, and other fragments of this genus were found at Ozark, Ala., none of which however, were well enough preserved for specific identification.

Mactra prætenuis var. **bistriata,** Pl. 13, fig. 10.

Syn. *M. prætenuis* Con., Foss. Sh., Tert. Form, p. 42, 1833. Harris' reprint, pl. 19, fig. 9.
M. prætenuis Con., Amer. Jour. Sci., vol. i, p. 217, pl. 2, fig. 4.
M. prœtenuis Ald., Bull. 1. Geol. Surv. Ala., p. 50. 1886.

Conrad's description of prætenuis.—"Shell sub-triangular compressed, equilateral, thin and fragile; umbonal slope sub-marginal, nearly rectilinear, carinated ; beaks slightly prominent ; lunule narrow elliptical ; two slightly prominent lines behind the umbonal slope." Locality, Claiborne sand.

There is some reason for supposing this to be a distinct species from *prætenuis*. It is smaller, and has both anterior and posterior umbonal slopes well and deeply marked by concentric lines, especially near the margins. This is especially true of the Sabinetown specimens.

Localities.—Alabama: 4 miles above Hamilton Bluff, on the Alabama ; Ozark. Texas: Sabinetown Bluff, Sabine River.

Type of prætenuis.—Acad. Nat. Sci., Phila.

Specimen figured.—Ozark, Ala. Paleont. Museum, Cornell University.

Corbula concha, Pl. 13, fig. 11.

Syn. *C. concha* Ald., Bull. Amer. Paleont. vol. i, p. 71, pl. 6, fig. 6, 1895.

Aldrich's original description.—"Shell oblong, ovate, inequilateral ; surface striate ; posterior somewhat produced and rounded, and the larger ; anterior elliptically rounded ; tooth large and oblong ; cicatrices very slightly impressed ; cavity of shell rather deep.

"*Locality.*—Bell's Landing, Ala.

"*Geological horizon.*—Bell's Landing, section of the Lignitic.

"A large species of this genus. It differs from any other by its smooth surface, large posterior end, and faint muscular impressions."

Our specimen is from near the mouth of Bashi creek, in the Woods bluff horizon.

Type.—Aldrich's collection.

Specimen figured.—Near the mouth of Bashi creek; Paleontological Museum, Cornell University.

Corbula aldrichi, Pl. 13, figs. 12, 13, a.

Syn. *Corbula rugosa* Heilp,, Proc. Acad. Nat. Sci., Phila., 1880, p. 364.
Corbula oniscus Heilp., Proc. Acad. Nat. Sci., Phila., 1880, p. 364.
Corbula gibbosa Heilp., Proc. Acad, Nat. Sci., Phila., 1880, p. 364.
Corbula aldrichi Meyer, Amer. Jour. Sci., vol. 30, p. 67, 1885.
Corbula aldrichi Ald., Bull. 1, Geol. Surv. Ala., p. 83, pl. 1, fig. 21, 1886.
Corbula rugosa Heilp., non Lam., Proc. Acad. Nat. Sci., Phila., 1890, p. 401.

Meyer's original description.—"Rounded trigonal ; ventricose; posterior side carinated ; beak small, curved anteriorly, in the left valve nearly in the middle ; right valve briefly rostrated ; in both valves the umbonal part is without concentric ribs, but with impressed, radiating lines—the ventral part with concentric ribs.

"*Locality.*—Woods Bluff, Ala.

"The radiating lines cut only the first ribs and and disappear completely at the ventral part. The species is similar to *Corbula gibbosa* Lea, but distinguished mainly by the smooth umbonal part and the radiating lines."

Heilprin has in several instances referred this species, as well as Conrad's *oniscus* and Lea's *gibbosa* to *C. rugosa* Lam. Were ones observations confined to the larger valve (right) this commingling of different species might be excusable. *C. aldrichi* does not always have radiating lines on the umbones nor are these parts always void of concentric striation. The radiate structure is made visible doubtless by slight erosion. Some specimens from Ozark, and 4 miles above Hamilton bluff, on the Alabama, and from Hatchetigbee, have the nasute posterior, the very strong liræ and in general, appear like small *oniscus*. But with them are specimens varying to the *aldrichi* type, and all left valves found are of the short, rotund shape of the latter species, and seem to have no relationship to the inferior, operculate, radially folded and grooved left valve of *oniscus*.

A very minute specimen from Gregg's landing, about as large as a pin head shows, when highly magnified, a smooth, rotund left valve, and a similar but larger right valve, strongly striate concentrically, to the very beak. No radii are present.

Type.—Aldrich's collection.

Localities (Lignitic).—Alabama: Woods Bluff; near mouth of Bashi creek; Gregg's Landing; 4 miles above Hamilton Bluff; Hatchetigbee; Ozark.

Specimens figured.—Hatchetigbee; Paleont. Museum, Cornell University.

Corbula alabamiensis var. Pl. 13, fig. 14, a.

Syn. *C. engonata* Ald.. Bull. 1, Geol, Surv. Ala., p. 58, 1886.

This variety is by no means so large nor so inflated as *alabamiensis*, yet some specimens seem to indicate a transitional stage so far as form is concerned. From *Corbula engonata* this is distinguished by its more compressed form, smaller concentric lines and more rectilinear base.

Locality.—Alabama: Gregg's Landing.

Specimen figured.—Paleont. Museum, Cornell University.

Corbula alabamiensis.

Syn. *C. nasuta* Con. (preoccupied) Foss. Sh., Tert. Form, p. 38, 1833; pl. 19, fig. 4 of Harris' republication.
C. alabamiensis Lea, Cont. to Geol., p. 45, pl. 1, fig. 12, 1833.
Corbula nasuta Ald., Bull. 1, Geol. Surv. Ala., p. 58, 1886.

Lea's original description.—"Shell inflated, triangular-ovate, angular behind, transversely and finely stiate, inequilateral, very inequivalve, anterior part the larger ; beaks incurved and rather pointed ; tooth of the right valve large, pointed and fitting under the beak of the left valve ; posterior basal margin straight or slightly emarginate; the two great cicatrices distinctly impressed; cavity of the valves deep. Diameter 7-20ths. Length .4. Breadth .7 of inch." Claiborne, Ala.

The specimens here included under typical *alabamiensis*, are much smaller than most specimens from Claiborne. There seems, however, to be little doubt of their identity.

Localities.—Alabama : Yellow Bluff ; 4 miles above Hamilton Bluff ; Hatchetigbee Bluff.

Type.—Academy Natural Sciences, Philadelphia.

Pholas alatoidea, Pl. 13. fig. 15.

Syn. *Pholas roperiana* Tuomey, 2d Biennial Rep't, 272, 1858.
Pholas alatoidea Ald., Bull. 1, Geol. Surv. Ala., p. 36, pl. 4, figs. 9, b, c, 1886.

Aldrich's original description. — "Shell elongate, cylindrical, posterior end concentrically striated, anterior half of the shell crossed with raised radial lines forming imbrications, which grow stronger as we approach this end. Anterior dorsal margin winged, this part showing only the continued concentric lines; umbonal processes large, reflected; anterior ventral margin strongly notched. Internal process broad, spatulate.

"*Localities.*—Gregg's Landing and Bell's Landing, Ala."

Type.—Aldrich's collection.

Specimen figured.—Gregg's Landing ; Paleont. Museum, Cornell University.

Glycymeris alabama, n. sp. Pl. 13 fig. 16.

Syn. *Panopœa* sp. Ald., Bull. 1, Geol. Surv. Ala., p. 58, 1886.
Panopœa porrectoides var? Har., Proc. Acad. Nat. Sci., Phila., 1896, p. 478, pl. 22, fig. 4.

Specific characterization.—General form of a well preserved specimen as indicated by the figure ; less developed anteriorly than *porrectoides* ; a slight or strong median constriction from umbo to base, causing oftentimes an indentation in the basal margin ; of a far more slender form, smaller size, and less symmetrical laterally than *elongata* Con.

Localities.—Alabama: Gregg's Landing. Georgia : Ft. Gaines, near base of Lignitic.

Type.—Lea Memorial Collection in Acad. Nat. Sci., Phila.

Specimen figured.—Lea Memorial Collection in Acad. Nat. Sci., Phila.

Martesia elongata, Pl. 14, fig. 1.

Syn. *M. elongata* Ald., Bull. 1, Geol. Surv. Ala., p. 37, pl. 4, fig. 10, 1886.

Aldrich's original description.—"Shell gaping above, elongated, sub-cylindrical; the anterior and central part of surface marked with concentric ribs, balance of posterior smooth. A strongly impressed groove running from the beak to the ventral margin, the concentric ribs being more pronounced on the sides of this groove.

"Beaks strongly recurved towards the anterior, situated close to this end, which is truncate.

"*Locality.*—Yellow Bluff, Ala., Bell's Landing Group."

"This species was taken from a piece of lignite by D. W. Langdon Jr. The shell has the markings of the dorsal accessory plate."

Type.—Herewith refigured, Aldrich's collection.

Lucina greggi. Pl. 14, figs. 2, 2a?

Syn. *L. greggi* Har., Proc. Acad. Nat. Sci., Phila., 1896, p. 478, pl. 22, fig. 6.

Harris' original description.—Size and general form as indicated by the figure ; marked exteriorly with concentric lines not deeply incised ; interior with two diverging cardinal teeth and an anterior lateral ; anterior muscular scar very large and extending from the anterior lateral tooth to the basal margin of the shell ; posterior muscular scar comparatively small, rotund ; interior naturally (or by disease) much thickened or calloused, a shallow channel extending from a little above the upper margin of the posterior muscular scar, obliquely to near the base of the anterior scar.

"A small specimen, magnified in fig. 5, [2a.] and probably of this species, shows an extremely, deeply excavated ligament pit, reminding one of *L. claytonia.* In the old type specimen, this pit broadens out and the ligament seems to be attached very much as in *Dosinia.*

"*Locality.*—Alabama: Gregg's Landing.

Type.—Lea Memorial Collection, in Acad. Nat. Sci., Phila.

Lucinia pomilia. Pl. 14, fig. 3, a. b.

Syn. *L. pomilia* Con., Foss. Sh., Tert. Form, p. 40, 1833.
L. impressa Lea, Cont. to Geol., p. 37, pl. 1, fig. 30, 1833.
L. pomilia Con., Amer. Jour. Sci., vol. i, p. 402, pl. 4, fig. 17, 1846.
L. pomilia Ald., Bull. 1, Geol. Surv. Ala., p. 57, 1886.

Conrad's original description. — "Shell suborbicular, equilateral, obscurely cancellated, with three or four profound concentric sulci ; and an indented fold on both sides, terminating in an emargination of the ends ; beaks prominent, lunule profoundly impressed, cordate ; cardinal and lateral teeth very distinct ; margin crenulated." From Claiborne, Ala.

The specimens in question (Lignitic) are much smaller than their Claiborne representatives and do not closely resemble the adults at the latter locality. Yet the young are the same from both horizons, and there is little doubt but that they are one and the same species.

Localities (Lignitic).—Alabama: Woods Bluff; Ozark; 4 miles above Hamilton Bluff.

Type.—Nat. Acad. Sci., Phila.

Specimens figured.—Woods Bluff; Paleont. Museum, Cornell University.

Lucina symmetrica? Pl. 14, fig. 4.

Syn. *L.rotunda* Ald., Bull. 1, Geol. Surv. Ala., p. 50, 1886.

This *Lucina* from Hatchetigbee, is somewhat closely related to *symmetrica* Con., *rotunda* Lea, but should presumably be described as new. We await more material from this and other upper Lignitic and lower Claiborne horizons.

Lucina ulrichi, Pl. 14, figs. 5, a. 6.

Syn. *L. ulrichi* Clark, Johns Hop. Univ. Circ., vol. xv, p. 5.
L. ulrichi Clark, Bull. U. S. Geol. Surv., No. 141, p. 79, pl. 21, figs. 1, a-d.

Clark's original description.—"Shell small, orbicular; surface with numerous, uniform, elevated, concentric ridges ; anterior and posterior sides rounded ; interior with radiating striæ ; margin simple. Dimensions: Length, 5 mm.; height, 4 mm.

"*Locality.*—Virginia: Woodstock.

The specimens we refer to this species are closely allied to *L. modesta* Con., from Claiborne. But in specimens from that locality the superior portion of the posterior margin extends beyond the inferior, while in this the reverse is true. Again, in the Claiborne specimens the anterior cardinal tooth in the left valve, is frequently well defined and vertical or sloping anteriorly downwards, while in this that tooth is not so clearly defined, and all other teeth are much more obliquely pitched. Again, *pomilia* has a finely crenulated margin. Clark's figures fail to show the internal striæ, and the muscular scars are certainly improperly drawn for the genus *Lucina*. The external ridges in our specimens are mere raised lines. The hinge characters are so represented that there is some doubt as to whether our specimens are really *ulrichi*.

Localities.—Woods Bluff; 4 miles above Hamilton Bluff, Alabama River.

Type.—Johns Hopkins University.

Specimens figured.—Woods Bluff; Paleont. Museum, Cornell University.

Lucina ozarkana n. sp. Pl. 14, figs. 7, a, b.

Specific characterization.—Size and general form as indicated by the figures ; exterior nearly smooth, but slightly marked concentrically with fine striæ and by a few more deeply impressed lines of growth or slight unconformability in growth ; radiating striation fine but visible ; post-umbonal area defined by a slightly depressed radiating line ; sub-lunule area, as well as post-umbonal area, with stronger, raised, imbricated lines ; interior with cicatrices as shown in the figure ; radiating lines prominent but fine ; umbonal teeth as indicated by the figures ; lateral teeth wanting, or with a faint trace anteriorly in the right valve.

Locality.—Alabama: Ozark, in R. R. cut.

Type figured.—Paleont. Museum, Cornell University.

Lucina astartiformis, Pl. 14, fig. 8.

We have no specimens of this species in our collections. See Bull. Amer. Paleont., vol. ii, p. 181.

Locality.—Alabama : Choctaw Corner.

Type.—Aldrich's collection.

Tellina greggi, Pl. 14, fig. 9, a–c.

Syn. *T. lignitica* Har., Proc. Acad. Nat. Sci., Phila., 1896, p. 477.
T. greggi Har., *ibid* pl. 22, fig. 3, a.
? *T. virginiana* Clark, Bull. 141, U. S. Geol. Surv., p. 76, pl. 15, fig. 4.

Harris' original description.—"Size and general form as indicated by the figures; substance of shell very thin; smooth; two cardinal teeth in each valve; a furrow in the upper anterior margin of the left valve causes the same to form two obscure teeth.

"*Locality.*—Alabama: Gregg's Landing."

In some unaccountable manner an old manuscript name, "*lignitica*," used in the first draft of the article referred to above, was not changed to the final name *greggi* before going to press. The figures herewith given will show some additional specific characters.

Localities.—Alabama: Yellow Bluff; Gregg's Landing.

Type.—Lea Memorial Collection in Acad. Nat. Sci., Phila.

Tellina (Arcopagia) trumani, n. sp. Pl. 12, fig. 15; pl. 14, fig. 10.

Specific characterization.—Size and general form as indicated by the figures; teeth in the left valve as shown in fig. 10, in the right as in fig. 10a; the anterior lateral of the right valve carries above it a deep groove for the like margin of the opposite valve.

Locality.—Gregg's Landing.

Type.—Paleontological Museum, Cornell University.

Tellina subtriangularis, Pl. 14, fig. 11, a-c.

Syn. *T. subtriangularis* Ald., Bull. Amer. Paleont., vol. i, p. 70. pl. 6, fig. 8.
? *T. williamsi* Clark, Bull. 141, U. S. Geol. Surv., p. 79, pl. 15. 3a, 3b, 1897.

Aldrich's original description.—(Loc. cit.)

Localities.—Alabama: Hatchetigbee Bluff; Woods Bluff; Ozark; 4 miles above Hamilton Bluff, Alabama River.

Type.—Aldrich's collection.

Specimen figured.—Woods Bluff, Paleont. Museum, Cornell University.

Solemya alabamensis, n. sp. Pl. 14, fig. 12.

Specific characterization.—Size and general form as indicated by the figure; sub-cylindrical; with four fine, rather prominent, radiating, curved ribs on the posterior, and finer lines on the remainder of the shell.

Locality.---Alabama: Alabama River, 4 miles above Hamilton Bluff.

Type.---Paleontological Collection, Cornell University.

Periploma butleriana, Pl. 14, fig. 13, a.

Syn. *P. butleriana* Ald., Bull. Amer. Paleont., vol. i, p. 71, pl. 6, fig. 3.

No specimens of this species are in our collection.

Localities.—Alabama: Butler; Baker's Bluff.

Type.—Aldrich's Collection.

Cuspidaria prima, Pl. 14, fig. 14.

Syn. *Neæra prima* Ald., Bull. 1. Geol. Surv. Ala., p. 38, pl. 6, fig. 14, 1886.

Aldrich's original description.—"Shell rotund, covered with rounded, close-set concentric striæ ; posterior with four radiating ribs ; anterior part smooth. Rostrum moderate, narrow, rounded, with a concave, almost triangular space between it and the body of the shell, the end curving upward ; ventral margin hollowed out ; dorsal margin rising slightly above the hinge line. Cartilage pit, minute, bent inward in left valve, which also has the posterior muscular impression strongly defined by a rib on the inner side running to the dorsal margin ; hinge line nearly straight

"*Locality*.—Alabama: Woods Bluff. (Lower bed).

Type.—Aldrich's collection.

* * * * *

(Plate 1).

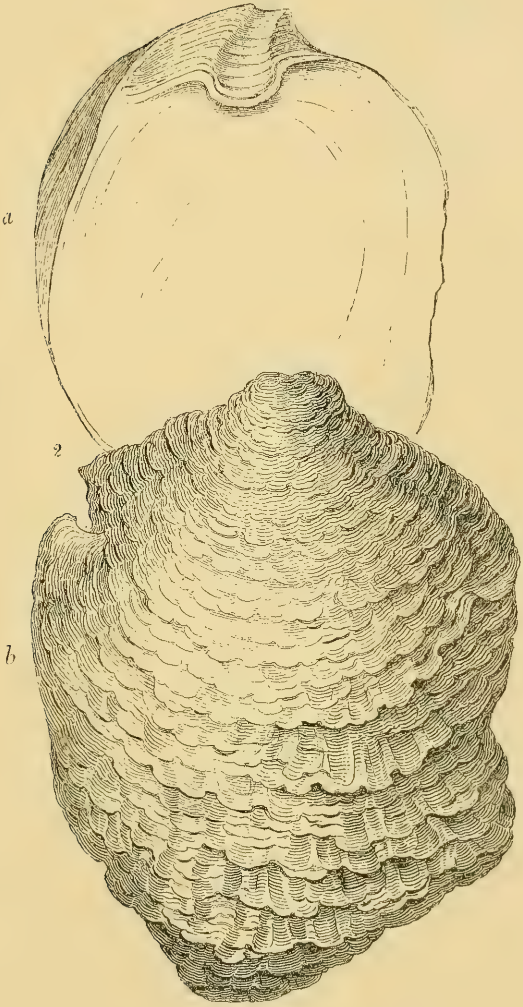
Plate 7.

EXPLANATION OF PLATE I.

(**7**)

	Page.
Ostrea compressirostra Say..	37, **229**

These figures were drawn by Lesueur to accompany Say's article in the Jonrnal of the Phila. Acad. Nat. Sci., vol. iv, 1824. See Bull. Amer. Paleont., vol. i, pl. 27.


a
2
b

(Plate 2).

Plate 8.

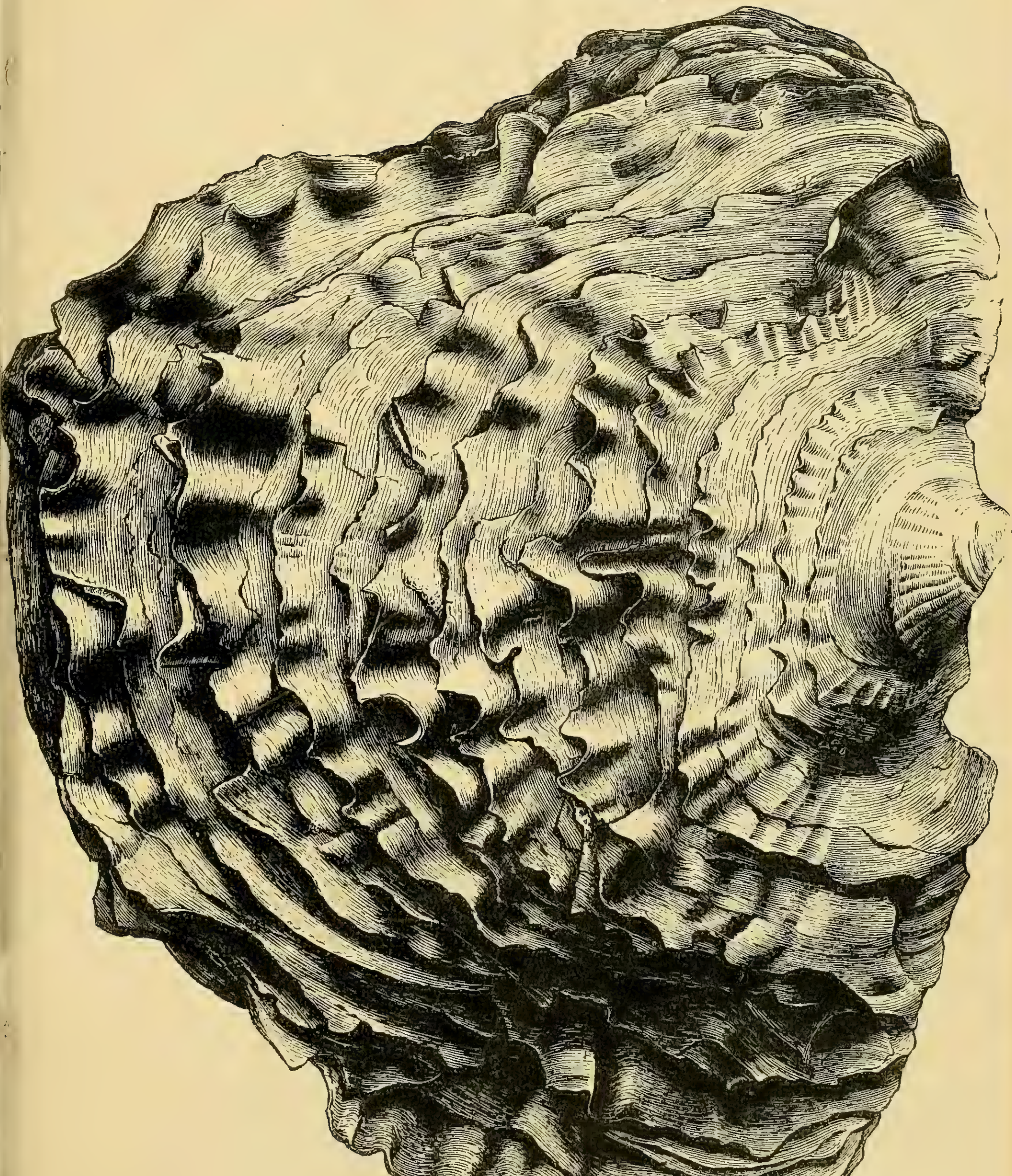
EXPLANATION OF PLATE 2.

(8)

Page.

Ostrea compressirostra Say.. 37, **229**

Exterior of a large and perfect left valve as figured in U. S. Geol. Surv. Rep't, 1883, pl. 65. Electrotyped for the present work by Joyce Eng. Co., Washington, D. C.



(Plate 3).

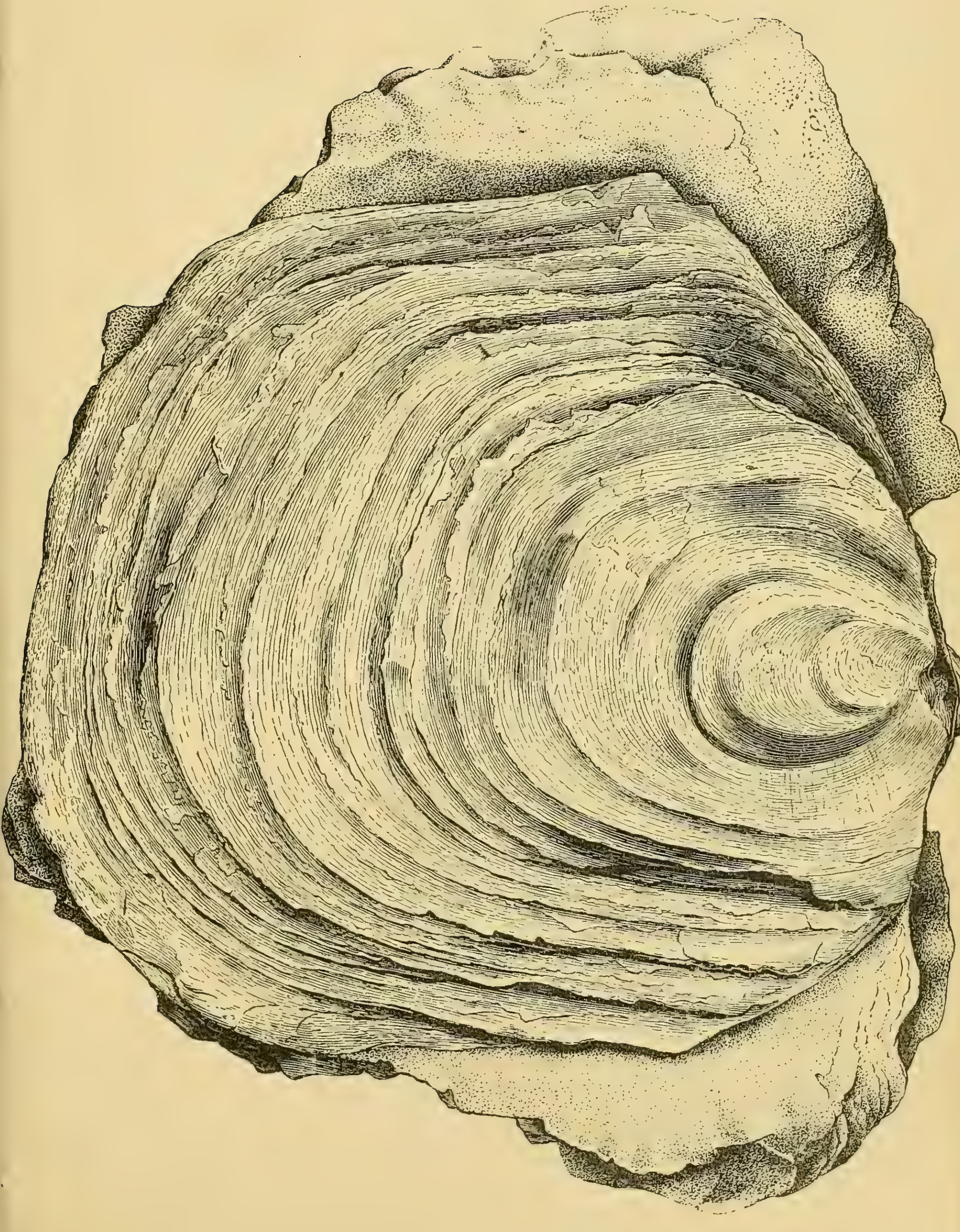
Plate 9.

EXPLANATION OF PLATE 3.

(**9**)

	Page.
Ostrea compressirostra Say..	37, **229**

Interior of right valve. See remarks under plate 2.



(Plate 4).

Plate 10.

EXPLANATION PLATE 4.

(10)

Page.

Ostrea trigonalis var. *sylværupis*.................................. 38, **230**

Showing exterior of large incrassated valves of this species as obtained from bed 8 at Woods bluff, Tombigbee river. See page 38. The work of boring mollusca is very apparent in the large left valve. Engraved by the Albany Eng. Co.

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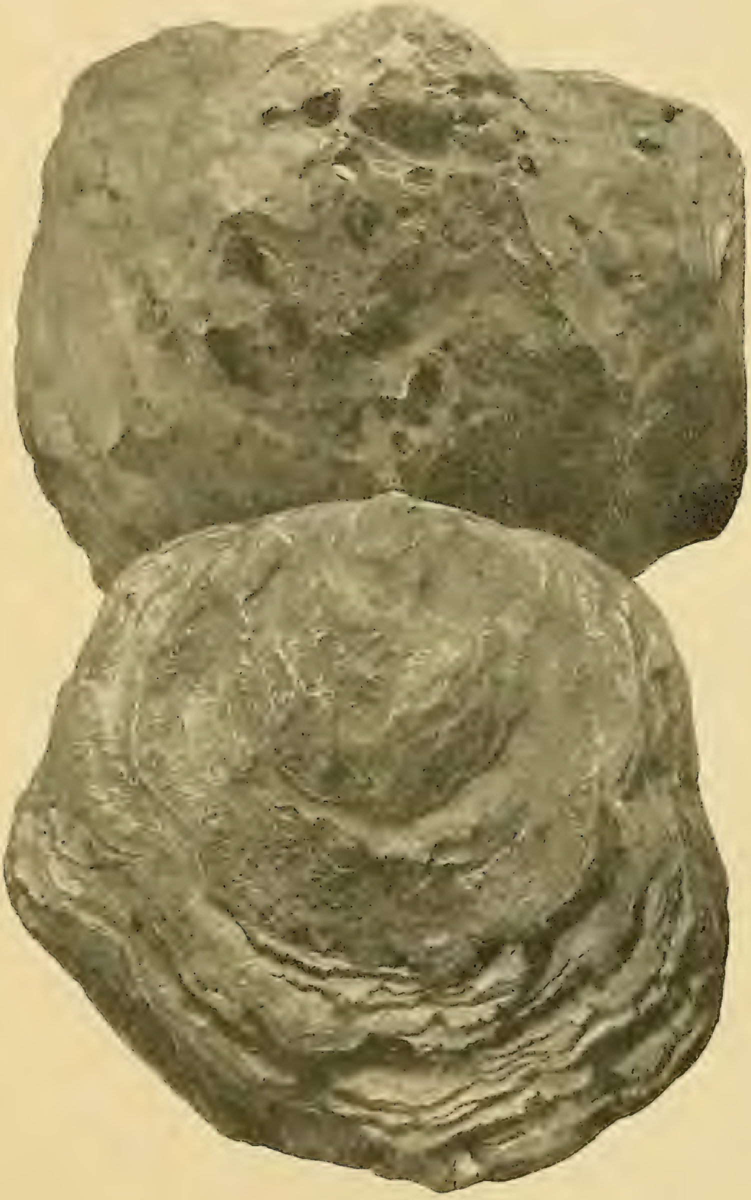


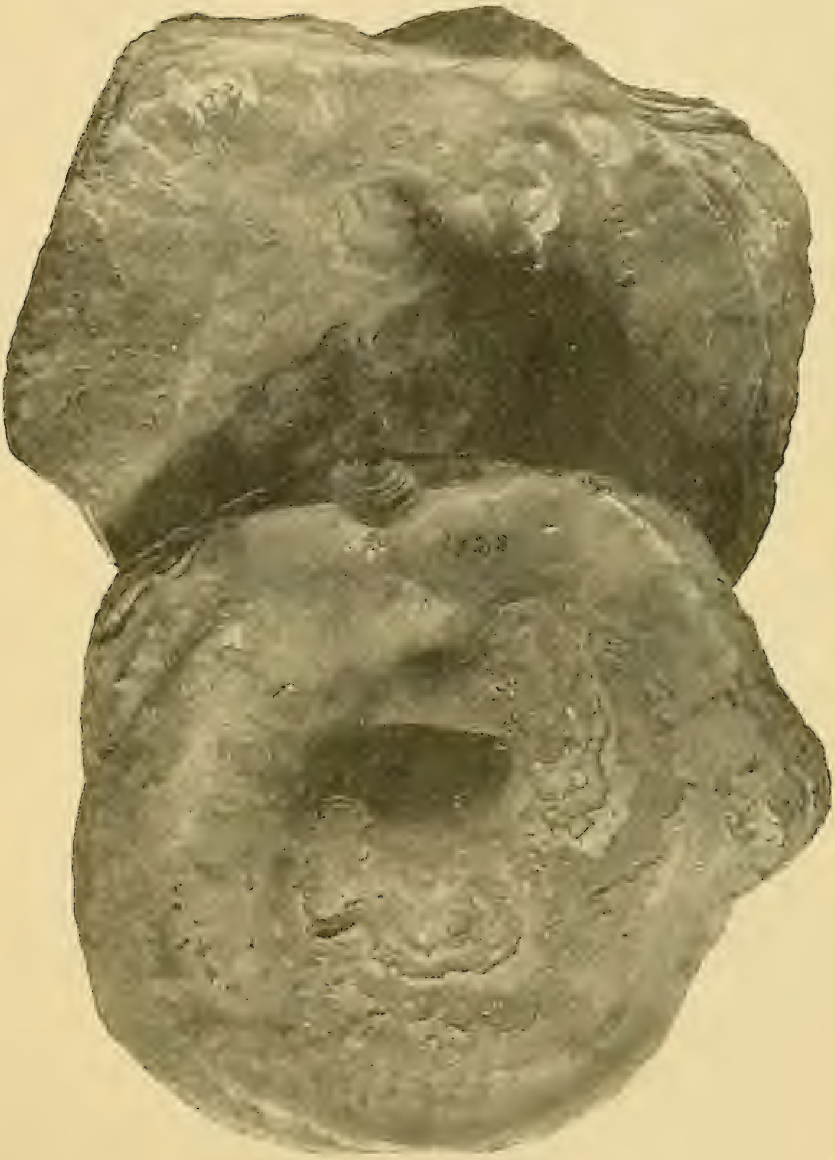
(Plate 5).

Plate 11.

EXPLANATION OF PLATE 5.

(**11**)

	Page.
Ostrea trigonalis var. *sylværupis*................................	38, **230**
Interior view. See remarks under pl. 4.	



(Plate 6).

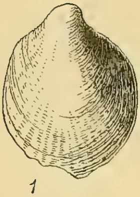
Plate 12.

EXPLANATION OF PLATE 6.

(**12**)

			Page.
Fig.	1.	*Ostrea compressirostra* Say, (young)	37, **229**
	2.	*Ostrea sellæformis* Con ?	41, **233**
	3.	*Ostrea* var. *sylværupis* Har. (young). Exterior of larger valve	38, **230**
	3a.	The same, lateral view.	
	4.	*O.* var. *sylværupis* Har. (young). Showing valves in normal position	" "
	5.	*Ostrea thirsæ* Gabb. Showing exterior of larger valve	40, **232**
	5a.	Interior of the same.	
	6.	*O. thirsæ* Gabb. Showing interior of lesser valve	" "
	7.	*O. alabamiensis* Lea. Showing radiate epidermal structure	41, **233**
	8.	*Plicatula filamentosa* Con. (var.)	" "
	9.	*P. filamentosa* Con., a larger specimen	" "
	10.	*Anomia* sp	42, **234**
	11.	*Spondylus*	" "
	12.	*Lima ozarkana* n. sp	43, **235**

Engraved by the Electro Light Engraving Company, New York.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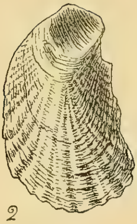
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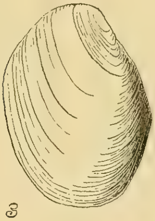
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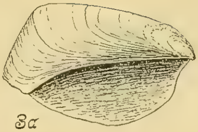
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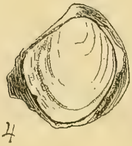
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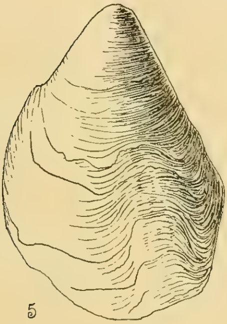
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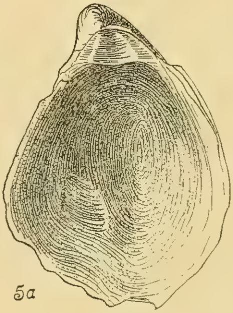
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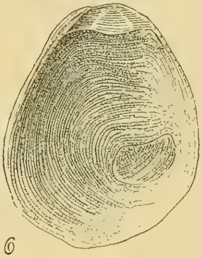
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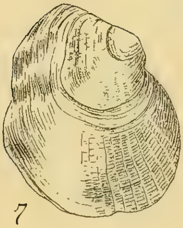
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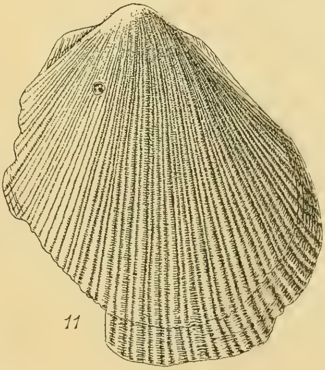
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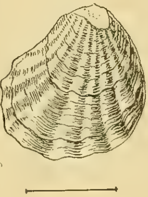
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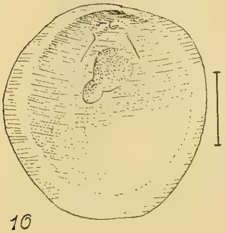
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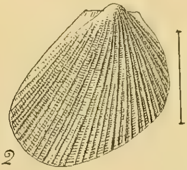
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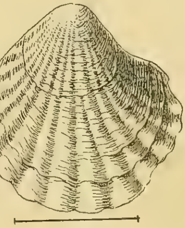
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(Plate 7).

Plate 13.

EXPLANATION OF PLATE 7.

(13)

			Page.
Fig.	1.	*Pseudamussium claibornense* Con	43, **235**
	2.	*Amussium squamulum* Lam	44, **236**
	2a.	The same, exterior.	
	3.	Another specimen showing fine radiate lines.	
	4.	*Chlamys greggi* n. sp. Left valve	45, **237**
	5.	Right valve of the same.	
	6.	*Chlamys choctavensis* Ald	46, **238**
	7.	*Avicula* sp	" "
	7a.	The same, exterior.	
	8.	*Pinna* sp	" "
	9.	*Modiola alabamensis* Ald	47, **239**
	10.	*Arca hatchetigbeensis* n. sp	" "
	10a.	The same, exterior.	

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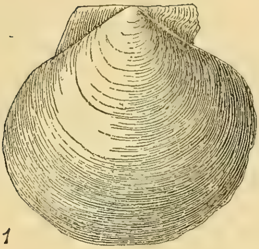

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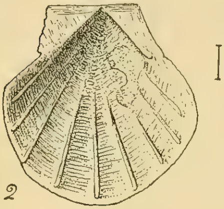

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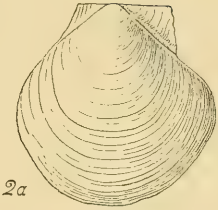

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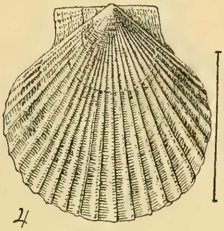

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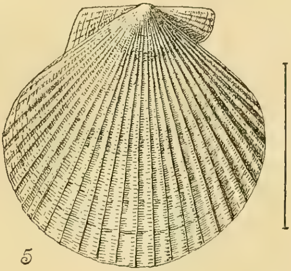

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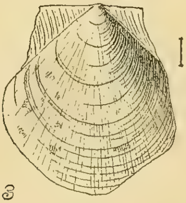

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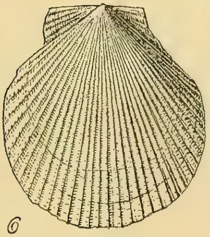

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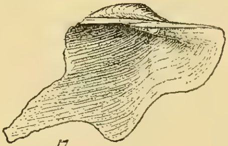

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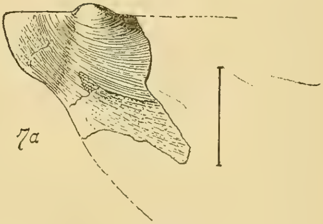

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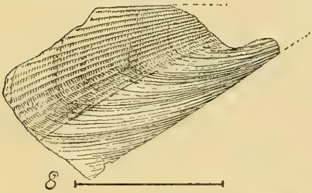

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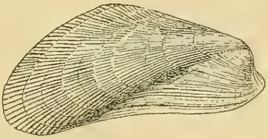

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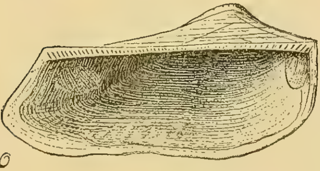

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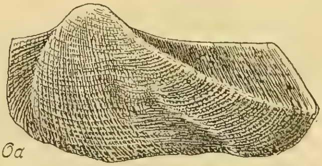

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(Plate 8).

Plate 14.

EXPLANATION OF PLATE 8.

(14)

			Page.	
Fig.	1.	*Barbatia cuculloides* Con. var	47,	**239**
	1a.	The same, exterior.		
	2.	*Trigonarca pulchra* Gabb, var	48,	**240**
	2a.	The same, interior.		
	3.	*Cucullæa gigantea* Con., var	49,	**241**
	3a.	The same, showing hinge.		
	4.	*C. gigantea* Con., var. Left valve	"	"
	5.	*Pectunculus idoneus* Con., var	"	"
	5a.	The same, interior.		
	6.	*P. idoneus* Con., var	"	"
	7.	*Nucula ovula* Lea	50,	**242**
	8.	*Leda elongatoidea* Ald	"	"
	9.	*L. elongatoidea* Ald., var	"	"
	10.	*Leda corpulentoides*	51.	**243**
	11.	*Leda corpulentoides*	"	"
	12.	*Leda marieana* Ald	"	"
	13.	*Leda protexta* Con	52,	**244**
	14.	*Leda parva* Rogers	53,	**245**
	15.	*Yoldia aldrichiana* Har	"	"

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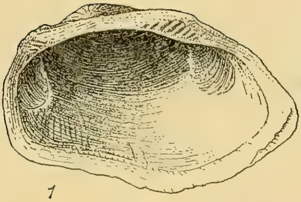
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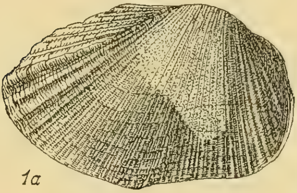
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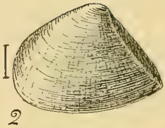
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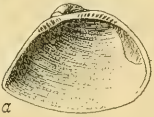
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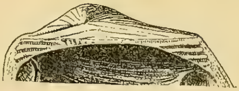
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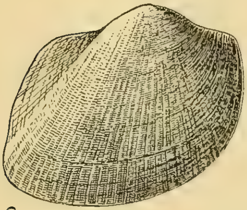
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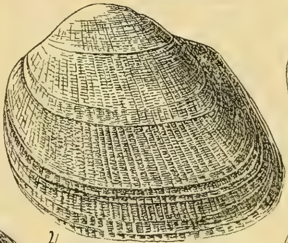
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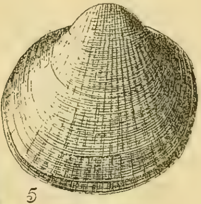
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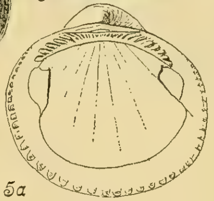
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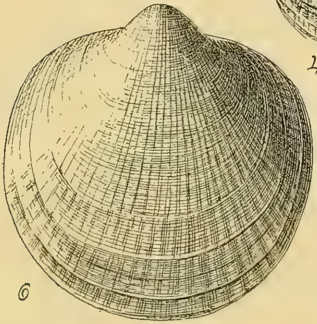
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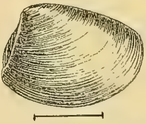
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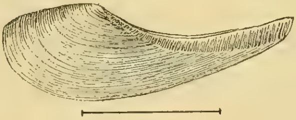
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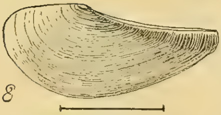
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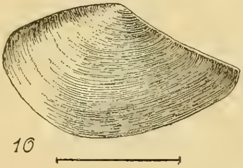
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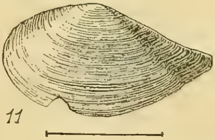
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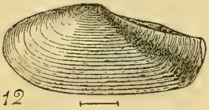
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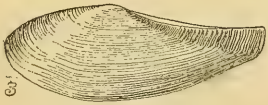
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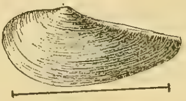
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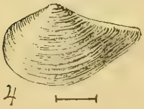
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(Plate 9).
Plate 15.

EXPLANATION OF PLATE 9.

(15)

Page.

Fig. 1. *Venericardia planicosta* Lam.................................. 54, **246**

A large right valve, nearly life size from Bell's landing; showing nasute posterior.

Fig. 2. *V. planicosta* Lam.................................... " "

A smaller, younger specimen of this variety from Bell's landing.

Fig. 3. *V. planicosta* Lam.................................... " "

Young of the variety shown by fig. 5, pl. 10.

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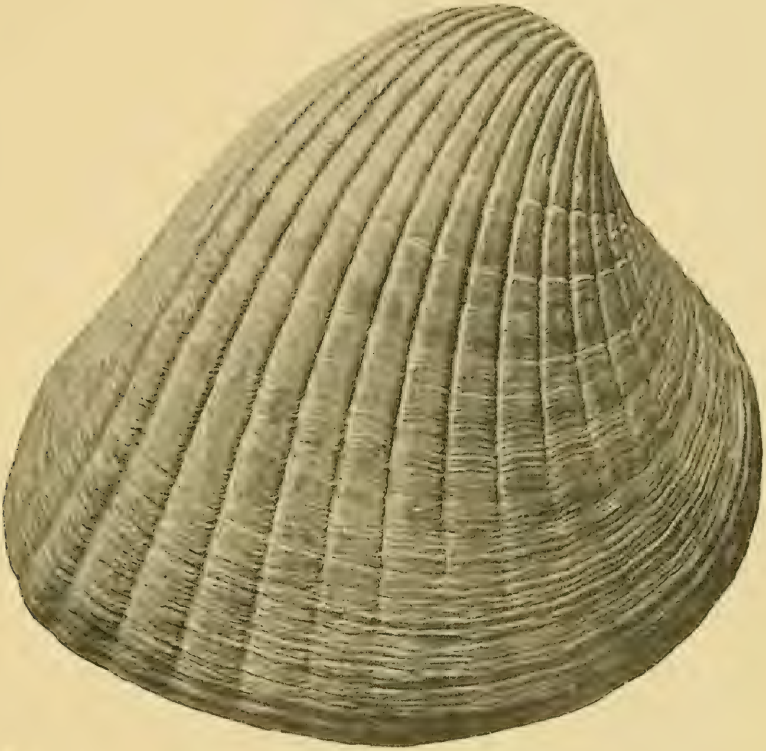

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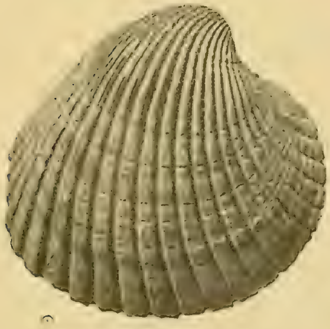

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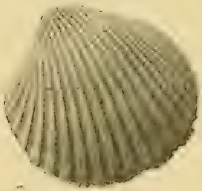

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(Plate 10).
Plate 16.

EXPLANATION OF PLATE 10.

(16)

		Page.
Fig. 1-4.	*Venericardia planicosta* Lam.	54, **246**
	Showing different stages of growth of an upper Lignitic and Lower Claiborne variety; ribs few, distinct, approximate at beak, becoming obsolete on the adult shell. All from Woods bluff.	
5.	*V. planicosta* Lam.	" "
	A common upper Lignitic and Lower Claiborne variety from Woods bluff.	

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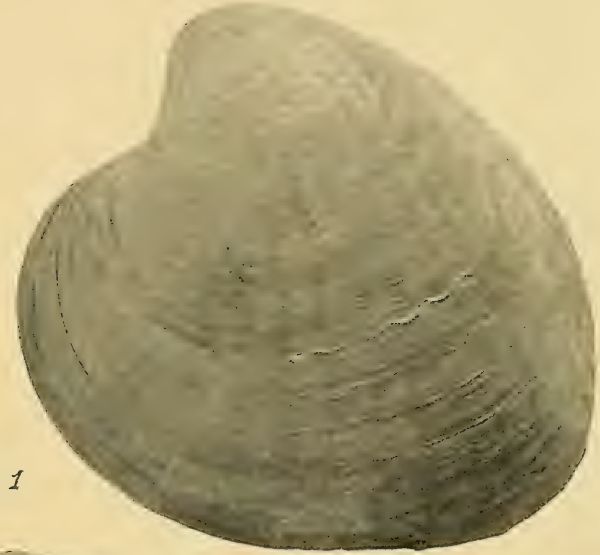

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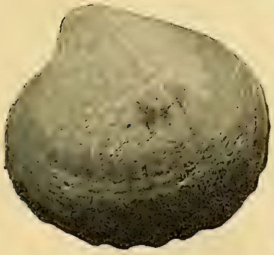

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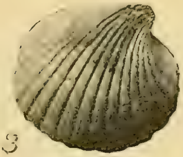

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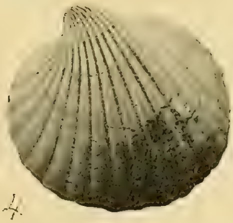

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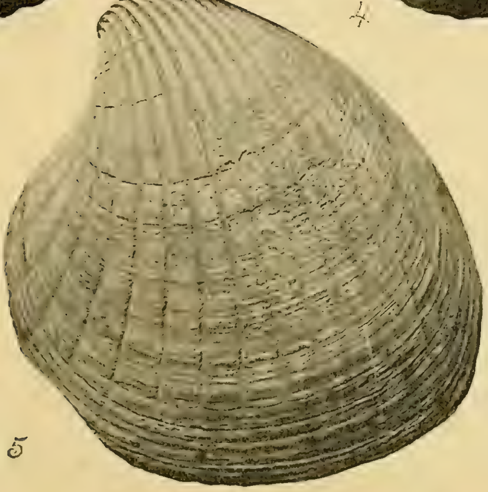

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(Plate 11).
Plate 17.

EXPLANATION OF PLATE 11.

(17)

			Page.
Fig.	1.	*Venericardia alticostata* Con. var.	55, **247**
	2.	*Astarte smithvillensis* Har.	56, **248**
	3.	*Crassatella tumidula* Whitf.	“ “
	4.	*C. tumidula* Whitf. Exterior view	“ “
	5.	*C. halei*, n. sp.	57, **249**
	6.	*Kellia prima* Ald.	58, **250**
	6a.	The same, interior.	
	7.	*Fabella oblonga* Ald.	“ “
	8.	*F. oblonga* Ald., exterior	
	9.	*Scintilla clarkeana* Ald.	“ “

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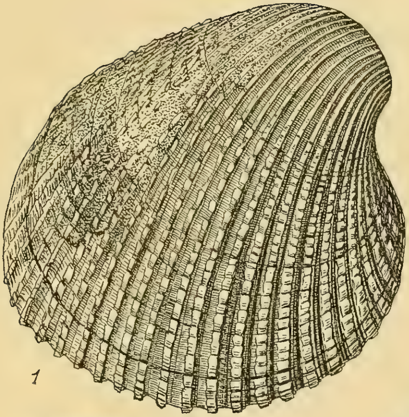

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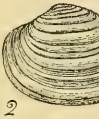

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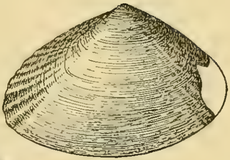

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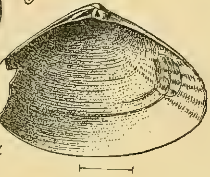

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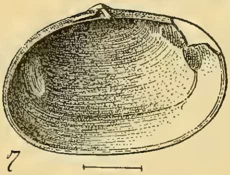

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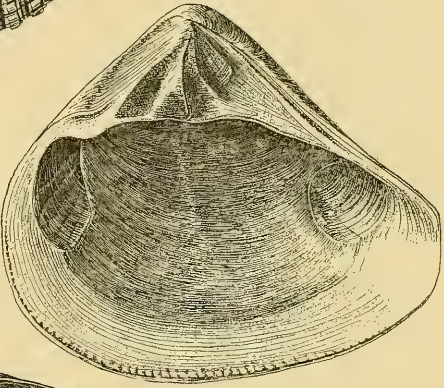

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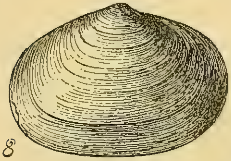

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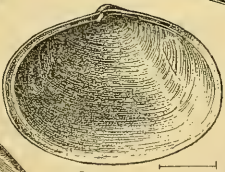

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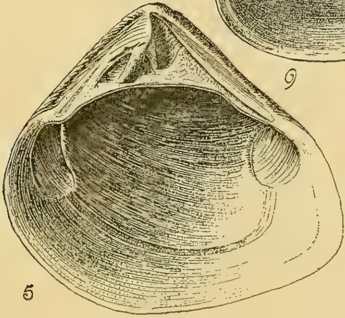

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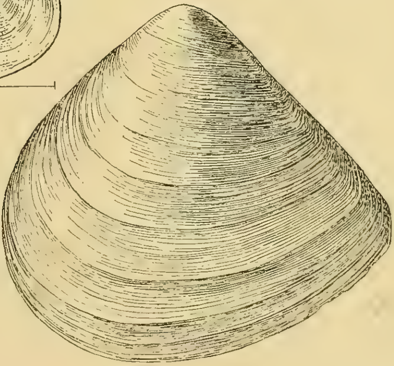

(Plate 12).

Plate 18.

EXPLANATION OF PLATE 12.

(18)

Fig.			Page.
Fig.	1.	*Protocardia lenis* Con. var.	58, **250**
	2.	*Cardium hatchetigbeense* Ald. Posterior view; one of Aldrich's types. See Geol. Surv. Ala., Bull. 1, p. 4, fig. 12b.	59, **251**
	2a.	*C. hatchetigbeense* Ald. Lateral view; one of Aldrich's types; *l. c.* fig. 12.	" "
	3.	*C. hatchetigbeensis ?* Ald. Large fragmentary specimen from Sabinetown, Texas.	60, **252**
	4.	*C. tuomeyi* Ald.	" "
	5.	*Meretrix nuttalliopsis* Heilp.	61, **253**
	6.	*M. subimpressa* Con. var.	63, **255**
	7.	The same species, interior view.	
	8.	*M. nuttalliopsis* var. *fulva*, n. var.	62. **254**
	9.	The same species, younger, more pointed.	
	10.	The same species, young, broad posteriorly.	
	11.	*Meretrix hatchetigbeensis* Ald.	63, **255**
	12.	The same species, interior.	
	13.	*Dosiniopsis lenticularis* Rogers	64, **256**
	14.	*Psammobia ozarkana*, n. sp. (See pl. 13, fig. 8)...	65, **257**
	15.	*Tellina trumani*, n. sp. (See pl. 14, fig. 10.)....	73, **265**

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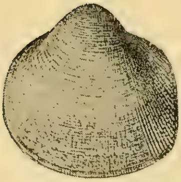
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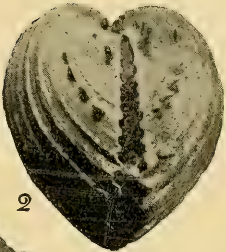
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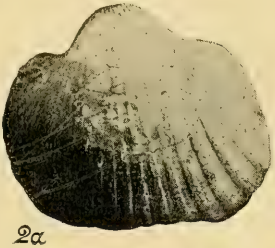
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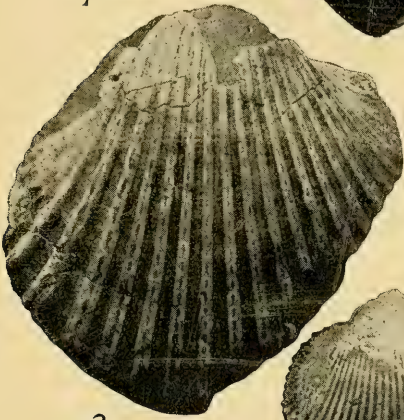
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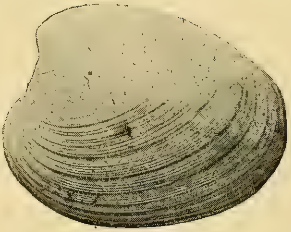
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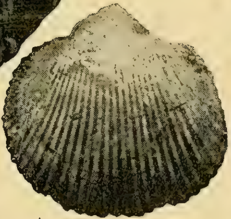
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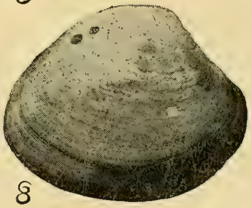
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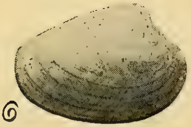
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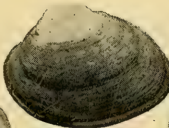
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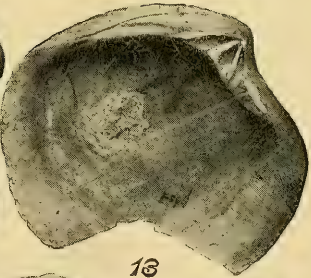
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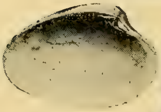
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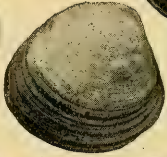
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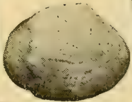
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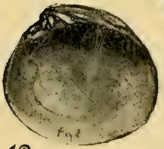
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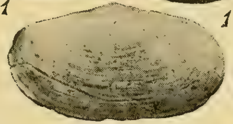
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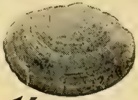
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(Plate 13).

Plate 19.

EXPLANATION OF PLATE 13.

(19)

		Page.
Fig. 1.	*Meretrix nuttalliopsis* var. *greggi* n. var. .8 natural size	62, **254**
2.	*Meretrix nuttalliopsis* var. *greggi* n. var. .8 natural size	“ “
3.	*Corbicula ? cornelliana* n. sp	65, **257**
4.	*Coralliophaga prima* n. sp	60, **252**
4a.	Interior of the same.	
5.	*C. prima* (edentulous)	“ “
6.	*Sphærella*	65, **257**
7.	*Diplodonta*	“ “
8.	*Psammobia ozarkana* n. sp	“ “
9.	*Solen*	66, **258**
10.	*Mactra prætenuis* var. *bistriata* n. sp	“ “
11.	*Corbula concha* Ald	“ “
12.	*C. aldrichi* Meyer, left valve, with radii	67, **259**
13.	*C. aldrichi* Meyer, showing right valve, exterior	“ “
13a.	*C. aldrichi* Meyer, showing right valve, interior	“ “
14.	*Corbula alabamiensis* var.	68, **260**
14a.	The same, exterior.	
15,	*Pholas alatoidea*	69, **261**
15a.	Inside, showing spoon-shape process.	
16.	*Glycymeris alabama* n. sp. .8 nat. size	“ “

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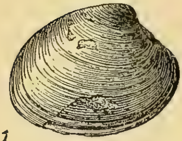

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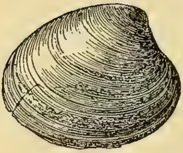

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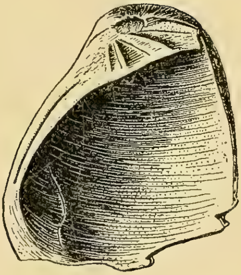

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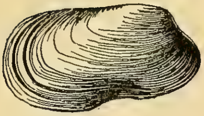

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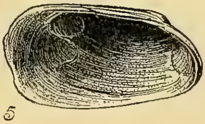

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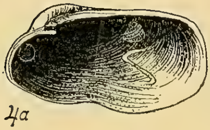

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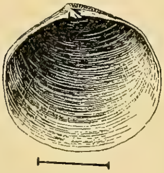

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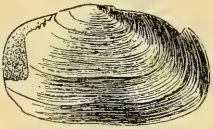

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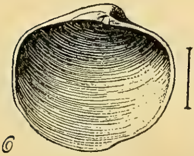

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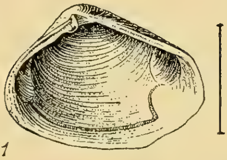

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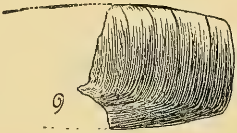

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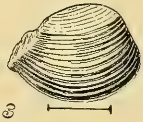

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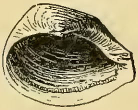

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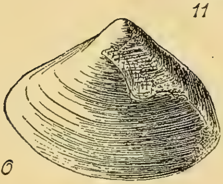

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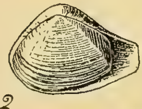

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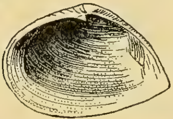

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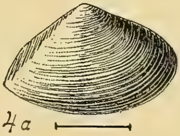

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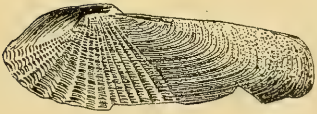

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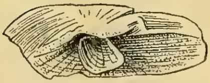

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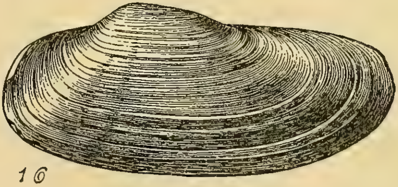

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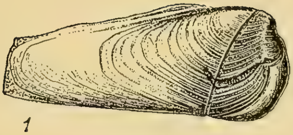
(Plate 14).

Plate 20.

EXPLANATION OF PLATE 14.

(20)

		Page.
Fig. 1.	*Martesia elongata* Ald.	69, **261**
2.	*Lucina greggi* Har., .8 nat. size	70, **262**
2a.	*Lucina greggi ?*, young	“ “
3.	*Lucina pomilia* Con., right valve	“ “
3a.	The hinge enlarged.	
3b.	Hinge of the opposite valve enlarged.	
4.	*Lucina symmetrica?*	71, **263**
5.	*Lucina ulrichi* Clark	“ “
5a.	Hinge of the same enlarged.	
6.	*L. ulrichi* Clark, left valve.	
7.	*L. ozarkana*, n. sp.	72, **264**
8.	*L. astartiformis* Ald., interior	“ “
8a.	The same, exterior.	
9.	*Tellina greggi* Har., exterior, .8 nat. size	“ “
9a.	The same, interior.	
9b.	The same; outline showing characteristic features.	
9c.	The same, hinge greatly enlarged.	
9d.	The same, hinge greatly enlarged.	
10.	*Tellina trumani* n. sp.	73, **265**
10a.	Hinge of opposite valve enlarged.	
11.	*Tellina subtriangularis* Ald.	“ “
11a-c.	The same, showing characteristic features.	
12.	*Solemya alabamensis*, n. sp.	“ “
13.	*Periploma butleriana* Ald.	74, **266**
13a.	Enlarged hinge of another specimen from Baker's bluff.	
14.	*Cuspidaria prima* Ald.	“ “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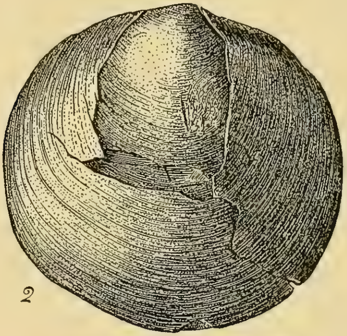
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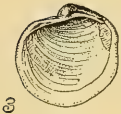
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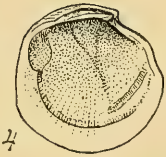
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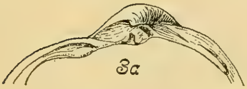
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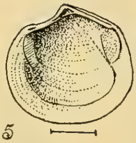
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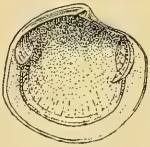
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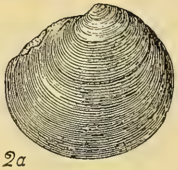
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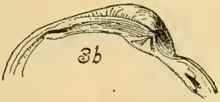
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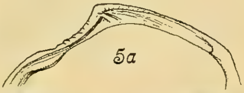
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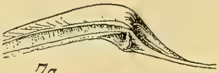
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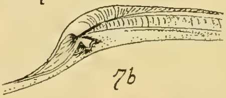
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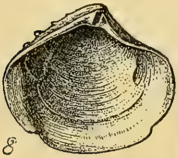
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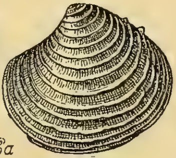
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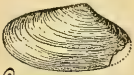
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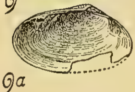
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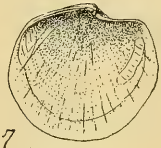
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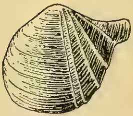
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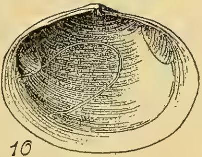
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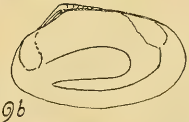
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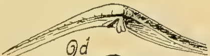
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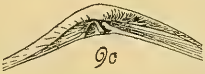
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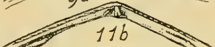
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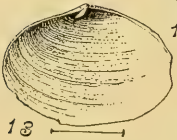
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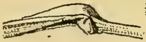
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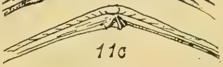
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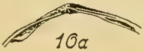
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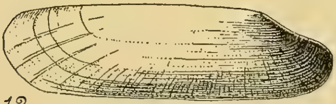
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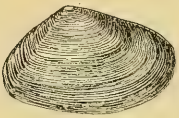
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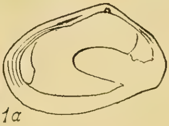
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No. 10

THE TERTIARY AND PLEISTOCENE FORAMINIFERA OF THE MIDDLE ATLANTIC SLOPE

BY

R. M. BAGG, JR., Ph. D.

March 15, 1898

Ithaca, N. Y.
U. S. A.

THE TERTIARY AND PLEISTOCENE FORAMINIFERA OF THE MIDDLE ATLANTIC SLOPE.

BY

R. M. Bagg, Jr.

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PREFATORY NOTE.

The investigations carried on in the preparation of this report have yielded fifty-six different species of Foraminifera. Twenty-five of these are from the Eocene, thirty-four are from the Miocene while the Pleistocene has furnished only four. In the above list are included a number of species which have been identified in greensand samples from deep artesian well borings made recently at Norfolk, Virginia, and at Crisfield, Maryland. Most of the species from these borings are undoubtedly from beds of Miocene age but some may belong to some other horizon. The Eocene specimens were nearly all obtained by the writer from the greensand marls of the Pamunkey river and Woodstock, Virginia, though a few were obtained at Marlboro, Maryland.

With the exception of *Cyclammina placenta* Reuss, which came from New Jersey the Miocene forms came from the classic localities of Yorktown and James river, Virginia, and from St. Mary's, Plum Point and Jones Wharf, Maryland.

The author is under obligation to Mr. Lewis Woolman of Philadelphia for the material from the artesian well at Crisfield and to Mr. N. H. Darton of the United States Geological Survey for the samples from Norfolk. Prof. W. B. Clark kindly gave me the interesting specimens of *Cyclammina* from New Jersey.

THE TERTIARY AND PLEISTOCENE FORAMINIFERA OF THE MIDDLE ATLANTIC SLOPE.

INTRODUCTION.

The material investigated from the Eocene marl beds of the Pamunkey river and Woodstock, Virginia, by the author, led to the discovery of twenty-three different species of Foraminifera, a classified list of which was published in Johns Hopkins University Circulars, vol. xv, 1895, p. 6, and again in Professor W. B. Clark's report* on the Eocene Deposits of the Middle Atlantic Slope in Delaware, Maryland, and Virginia. Later studies on Miocene deposits of several localities in Maryland and Virginia and from the Pleistocene beds at Cornfield Harbor, Maryland, resulted in the determination of a large number of genera and species. The presence of so many microscopic organisms proves how favorable were the conditions for their existance when these formations were being laid down.

HISTORICAL SUMMARY.

The first description of Foraminifera from the Miocene of Maryland appears to have been made by Isaac Lea in his Contributions to Geology. This work, published in 1833, contains an article entitled "Description of six new Species of Fossil Shells from the Tertiary of Maryland and New Jersey." which was read before the American Philosophical Society, November 1, 1833.

One of the forms, *Miliola marylandica*, described on pages 215 and 216 , and figured on plate VI, fig. 227, represents a smooth *Milioline* shell of three visible segments. This form is undoubtedly identical with *Miliolina seminulum* (Linné), and is so considered in this report.

Prof. J. W. Bailey† in 1845 figures two *Rotaline* casts, one from the greensand of Fort Washington, Maryland, the other from Virginia, but the horizon from which they were obtained is unknown. As both Eocene and Cretaceous occur at Fort Washington the specimen found there could belong to either horizon, though it is more probable that it came from the Eocene greensand.

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*Bul. U. S. Geol. Snrv., No. 141, pp. 91-92, 1896.

†Am. Jr. Sci., vol. xlviii, pp. 321-343, pl. iv, 1845.

In the Journal of the New York Microscopical Society for April 1887, Mr. Anthony Woodward gives a list of species which he identified in some Miocene sand enclosed in a *Pectunculus* shell from Petersburg, Virginia. This shell had lain undisturbed for many years and when examined yielded twenty-one different species of *Foraminifera.* The following year in Otto Meyer's Report* upon Upper Tertiary Invertebrates from the west side of Chesapeake bay, Mr. Woodward mentions three species; *Miliolina seminulum* (Linné), *Gaudryina pupoides* d'Orbigny, and *Polymorphina compressa* d'Orbigny. The latter I found to be very abundant and wide-spread, occurring in many localities and it is present in both Eocene and Miocene deposits.

In the reports upon the artesian well borings of New Jersey made during the last few years Mr. Lewis Woolman of Philadelphia has recognized the presence of Foraminifera many times but so far as I am aware he has not determined the various species observed. It is probable that these samples from the well borings will furnish a number of species when systematically studied, especially those of the Miocene age.

This seems to be all that has been done upon the Foraminifera of the Middle Atlantic Slope up to the present time. Nearly all species previously recognised have been identified by the writer and many forms are here described for the first time from the Atlantic Slope Tertiary. Two forms are believed to be new. One, *Spirillina orbicularis*, is from the Miocene beds of Yorktown, Virginia; the other, *Spiroplecta clarki*, is from the Eocene of Woodstock, Virginia. Until the discovery of the genus *Spiroplecta* by the author in the Virginia Eocene this was unknown in deposits of Tertiary age although it was known in the Cretaceous and is found in existing oceans.

LITHOLOGICAL CHARACTER OF THE DEPOSITS.

The mineral glauconite plays an important part in the Eocene formation of the Middle Atlantic Slope and in some localities constitutes almost the entire bed. This greensand is often argillaceous and constitutes with the shell material present a true marl, which in many places is so indurated as to form limestone bands. This feature is well illustrated on the Potomac river at the mouth of Aquia creek, Virginia where the huge boulders from the lower indurated layers lie scattered along the beach. The same is also seen at Fort Washington, Piscataway creek, Henson branch, Marlboro, Maryland, and at other places. Where the glauconite has weathered the characteristic bluish-green color is changed to a light gray or redish-brown, which from the large amount of iron present is often cemented into a ferruginous sandstone. This is particularly well illustrated in the bluffs along the Severn river. The land-derived element which is present in addition to the argillaceous material is chiefly quartz, together with some mica and sometimes these materials predominate forming beds of gray sands or sandy clays.

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*Proc. Acad. Nat. Sci. Phila., 1888, pp. 170-171.

Prof. W. B. Clark mentions the occurrence of a coarse pebble bed which has been found in some localities at the base of the formation. The following chemical analyses taken from Prof. Clark's Report above mentioned serve well to show the composition of the greensand.

Analyses of Marls.

	Woodstock, Va.	**Evergreen, Va.**	**Aquia Creek, Va.**	**Winchester Md.**
H_2O at 110°	3.58	3.11	0.76	1.31
Volatile at red heat less CO_2	2.84	2.60	.21	6.27
Al_2O_3&Fe_2O_3*	22.68	21.50	7.70	41.25
CaO	1.66	2.50	36.78	None
MgO	2.77	2.06	1.05	.76
K_2O	.77	.61	.37	.39
Na_2O	.23	.31	.59	.42
SiO_2	60.87	63.94	21.58	49.08
CO_2	3.17	3.53	29.79	.55
P_2O_5	None	None	.09	.13
	98.57	100.16	98.92	100.16
Silicious matter	73.48	75.85	25.36	52.30

*A considerable Fe_2O_3 in all samples.

While the Eocene is more or less homogeneous throughout its whole extent the Miocene shows marked variation in its lithologic character. In New Jersey the lower portion of this formation overlying the marl beds consists of a black micaceous sandy clay often rich in organic matter and is commonly termed "rotten-stone." Near the base of the formation glauconite occurs more or less sparingly dispersed owing to the transgression of the Miocene sea upon the marl beds. Where the Eocene is absent the writer has found this sandy clay filled with casts of small Panopæas and other Miocene shells directly above the Lime-sands of the Rancocas formation. A good illustration of this is seen in the bank by the mill-pond at Harrisonville, Gloucester county, New Jersey.

Overlying this dark sandy clay are fine micaceous sands pinkish or yellowish in color, the character of which is best described by the words, fluffy or mealy. In some places this sand carries enough argillaceous material to serve as a moulding sand and is so used by Mr. Wilson who ships it to Philadelphia from his pits not far from Harrisonville. The famous glass sands of New Jersey belong to this period. In some cases the sand has become consolidated so completely as to form a veritable quartzite as is seen in the pits of Gilbert A. Ayre near Marlboro, Cumberland county, N. J. The marl beds so largely worked in Cumberland county while exceedingly rich in Mollusca seem to be without Foraminifera, at least the author has found none in the material examined. That they are present in many of the Miocene clays has been proven by the well-borings.

In Maryland and Virginia the Miocene has a wide representation and consists of clays, sands, and shell marl. The clays are often developed in lenticular bands as is seen in the bluffs by Yorktown. This clay in that vicinity yields a number of Foraminifera belonging to the *Miliolidæ* which indicate a warm climate. The great thickness of Infusorial earth developed in Maryland and Virginia must be mentioned although the fossils found in it belong to other microscopic groups.

The Pleistocene Foraminifera from Cornfield Harbor, Maryland, occur in a deposit of shell marl not unlike that which characterizes the Miocene. There are a large number of forms present in this deposit but they are limited to four or five genera of which the genus *Polystomella* plays the most important part. That the deposits were formed in shallow water throughout the Tertiary period seems abundantly proven by the great abundance of *Pulvinulina elegans* d'Orbigny, in the Eocene, and the absence of its relative, *Pulvinulina partschiana* d'Orbigny, a deep water species, by the presence in the Miocene of such species as *Rotalia beccarii* (Linné), *Nonionina depressula* (Walker & Jacob), and in the Pleistocene by the abundance of *Polystomella striato-puncta* (Fichtel & Moll).

The bibliography herein given contains a list of the literature which has been most helpful in the preparation of this report and is intended to include nearly everything which has been published on American Tertiary Foraminifera. Only a limited number of the most useful European works are cited here.

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* * *

DESCRIPTION OF SPECIES.

PROTOZOA.

Rhizopoda.

FORAMINIFERA.

Cyclammina placenta.

Syn. *Nonionina placenta* Reuss, Zeitsch. deutsch. geol. Gesell, 1851, p. 72, pl. v, fig. 33.

Halophragmium placenta, Andreæ, Beitrag zur Kent. Elsass. Tertiars, Theil ii, p. 105, pl. vii, fig. 6, 1884.

Test large, discoidal, compressed, of a snow white color, consisting of numerous irregular chambers, about fifteen in the final convolution; peripheral margin somewhat lobulated, septal lines distinct, slightly depressed, irregularly curved; peripheral margin rounded; septal plane rather large, ovoidal; diam. 3.10 mm.

Horizon and Locality.—Miocene, near Mullica Hill, N. J.

Geological distribution.—Oligocene, and Miocene.

In the description of the above genus by Prof. H. B. Brady in the Challenger Report, vol. ix, p. 351, the author states that *Cyclammina* is unknown in the fossil state, but there can be no longer any doubt about its occurrence in deposits of middle Tertiary age. The finely arenaceo-silicious test unaffected by acids, its peculiar complex structure, and its shape, make it easily recognized.

Textularia abbreviata.

Syn. *Textularia abbreviata* d'Orbigny, Foram. Foss. Vien., p. 249, pl. xv, figs. 9-12 (error for 7-12), 1846.

Test short and thick, sharply pointed at the posterior end, rapidly enlarging above, laterlly compressed but not strongly so being broadly elliptical in outline with narrowly rounded margins approaching angularity. The chambers are narrow and increase in size rapidly towards the ultimate chamber; septal lines straight; apparent as fine lines; aperture a semilunar arch on the interior margin of the final segment.

Horizon and locality.—Miocene; James river, Va.

Geological distribution.—Tertiary.

The genus *Textularia* is represented by several species in the James River Miocene. The material from which the Foraminifera were extracted came from the bluffs at Grove's Landing.

Textularia agglutinans.

Syn. *Textularia agglutinans* d'Orbigny, Foram. Cuba, p. 136, pl. 1, figs. 17, 18, 32-34, 1839.

Textularia agglutinans Brady, Chal. Rep't, vol. ix, p. 363, pl. xliii, figs. 1-3, var. figs. 4 and 12, 1884.

Test agglutinous, elongated, tapering only slightly, of a dull gray color, convex laterally, peripheral margin lobulated, rounded, chambers numerous, nine or ten in each series, septa somewhat curved, short. Length 1.10 mm.

Horizon and locality.—Miocene; Plum Point, Md. Not common.

Geological distribution.—Cretaceous to Recent.

Textularia articulata.

Syn. *Textularia articulata* d'Orbigny, Foram. Foss. Vien., p. 250, pl, xv, figs. 16-18, 1846.

Test broad, laterally compressed, tapering only slightly toward the posterior end which is slightly rounded; peripheral margin sharp and provided with a marginal keel encircling the sides of the whole shell; chambers numerous, about ten in each series, separated by straight or only slightly curved septa; aperture a small median opening along the inner margin of the final segment; length 0.65–0.86 mm.

The above species is closely allied to *Textularia carinata* d'Orbigny but differs in the absence of marginal irregularities and spines, and the sutures are not quite as limbate.

Horizon and locality.—Miocene; Plum Point, Md.

Geological distribution.—Middle and Upper Tertiary.

Textularia gramen.

Syn. *Textularia gramen* d'Orbigny, Foram. Foss. Vien., p. 248, pl. xv, figs. 4, 6, 1846.

Textularia gramen Brady, Chal. Rep't, vol. ix, p. 365, pl. xliii, figs. 9, 10, 1884.

Test arenaceous, rough, stoutly built, laterally compressed, margin subangular, five to seven wide chambers in each series, very slightly convex, posterior end neatly rounded, general outline very similar to *Textularia hauerii* d'Orbigny, but separated from that species by its more angular lateral edges, and differing from *Textularia abbreviata* d'Orbigny, which it also resembles, in being less short and thick; length, .50-.78 mm.

The above species is quite common in the Miocene of Virginia.

Horizon and locality.—Miocene; James river and Yorktown, Va.

Geological distribution.—Cretaceous to Recent.

Textularia sagittula.

Syn. *Textularia sagittula* Defrance, Dict. Sci. Hist., vol. xxxii, p. 177; vol. liii, p. 344; Atlas Conch., pl. xiii, fig. 5, 1824

Textularia sagittula Brady, Chal. Rep't, vol. ix,, p. 361, pl. xlii, figs. 17, 18, 1884.

Test elongated, strongly compressed with sharp-angled peripheral margins; chambers numerous, closely set, separated by short, straight septal lines visible externally; aperture linear; length 0.69–1.10mm.

Horizon and locality.—Eocene; Marlboro, Md.
Miocene; James river, Va.; Plum Point, Md.

Geological distribution.—Cretaceous to Recent.

Textularia subangulata.

Syn. *Textularia subangulata* d'Orbigny, Foram. Foss. Vien., p. 274, pl. xv, figs. 1-3, 1846.

Test consisting of a relatively small number of chambers which increase very rapidly in size from the posterior to the anterior end; peripheral margins sharp-angled. The sides of the shell are laterally compressed and parallel, only their extremities forming the sharp-angled periphery; posterior end acuminate, anterior broad and obtusely rounded; ultimate chamber much elevated and larger than any other segment; aperture an arched median slit along the inner margin of the final segment; length 1.0 mm.

Horizon and locality.—Miocene; James river, Va.

Geological distribution.—Tertiary.

Spiroplecta clarki.

Syn. *Spiroplecta clarki* Bagg, Johns Hopkins Univ. Circulars, vol. xv, p. 5, 1895.

Test elongate, textulariform, finely arenaceous, firmly cemented; compressed strongly, lateral margins sharp and very slightly lobed; surface of shell rough, of a dull gray color; chambers at first planospiral then arranged biserially with nine and ten respectively on each side; aperture a median arched opening; length 0.53 mm., breadth 0.20 mm.

The occurrence of *Spiroplecta* has never been reported from the Tertiary formation, save in the present instance, so far as I am able to learn. It has, however, been described from the Cretaceous of Mississippi and from the Gault and Chalk of England (Parker & Jones), and is sparingly found in present oceans (Brady). It has also been reported from the Post-tertiary beds of the northeast of Ireland (Wright).

The above specimens which have been identified as belonging to the genus *Spiroplecta* seem to be new. They more nearly resemble *Spiroplecta biformis* Parker & Jones, but differ from that species in the possession of sharp angular edges. The distal end is more obtusely rounded than in Textularian types and the chambers are less regularly developed. Only two specimens have thus far been discovered.

Horizon and locality.—Eocene; Woodstock, Va.

Geological distribution.—Eocene.

Genus *BULIMINA* d'Orbigny.

Bulimina aculeata.

Syn. *Bulimina aculeata* d'Orbigny, Ann. Sci. Nat., vol. vii, p. 269. No. 7, 1826.

Bulimina aculeata Brady, Chal. Rep't, vol. ix, p. 406, pl. li, figs. 7-9, 1884.

Test composed of numerous irregular sized chambers arranged in a short triserial spire; anterior end obtusely rounded and free from surface ornamentation, posterior ending rather bluntly and furnished with spines, the lower chambers also have spines and irregular ridges more or less developed; length .60 mm.

This is not a common form in the Virginia Miocene. Its peculiar surface ornamentation makes it easy to identify.

Horizon and locality.—Miocene; James river, Va.

Geological distribution.—Miocene.

Bulimina buchiana.

Syn. *Bulimina buchiana* d'Orbigny, Foram. Foss. Vien. p. 186, pl. xi, figs. 15-18, 1846.

Bulimina buchiana Brady, Chal. Rep't, vol. ix, p. 407, pl. li, figs. 18, 19, 1884.

Test short and stout, triserial, tapering; posterior end acutely rounded, anterior obtuse; segments distinct, slightly inflated; surface of shell marked by definite longitudinal costæ, which extend from the posterior to near the central portion of the final segments. Aperture an elongated slit near the lower portion of the septal plane; length variable.

Prof. H. B. Brady considers that this form occupies an intermediate position between *Bulimina inflata* and *Bulimina rostrata*, but the costæ of the former are short and extend into stout spines beyond the margin of the chambers, while the costæ of *Bulimina rostrata* are continuous and cover almost the whole test and the segments are either indistinct or entirely concealed.

This species is very common at a depth of 645 feet in the well boring at Norfolk, Va.

Horizon and locality.—Miocene; Norfolk, Va., common in well borings, depth 645 to 695 feet.

Geological distribution.—Eocene to Recent.

Bulimina elongata.

Syn. *Bulimina elongata* d'Orbigny, Foram. Foss. Vien., p. 187, pl. xi, figs. 19, 20, 1846.

Test very much attenuated though tapering but slightly from end to end; segments short, oval, somewhat irregularly arranged and lobulated at the margins, not smooth as in *Bulimina imbricata* Reuss, which it somewhat resembles; primordial end sharply, anterior obtusely rounded; chambers numerous, of irregular size and separated by depressed septa; ultimate chamber provided on its septal face with a comma-shaped aperture; length 0.37 mm,

Horizon and locality.—Miocene; Plum Point, Md., rare.

Geological distribution —Lower Tertiary to Recent.

Genus *SPIROLOCULINA* d'Orbigny.

Spiroloculina planulata.

Syn. *Miliolites planulata* Lamarck, Ann. du Museum, vol. v, p. 352, No. 4, 1805.; Anim. sans Vert., vol. vii, p. 613, No. 4, 1822.

Spiroloculina planulata Brady, Chal. Rep't, vol. ix, p. 148, pl. ix, fig. 2, a, b, 1884.

Test free, calcareous, imperforate, oval, complanate, and only slightly depressed at the center; chambers smooth, compressed, placed alternately on opposite sides of the shell. The peripheral margins are gently rounded. The aperture is in the form of a narrow high arched or horse-shoe shaped opening with a projecting tongue at the lower margin; length 0.90 mm, breadth 0.60 mm.

I have only one specimen of this interesting species. According to Prof. H. B. Brady, recent specimens of this form are found abundantly on the shores of the British Isles, and in temperate seas it has a wide distribution but it is unknown in the cold water of arctic latitudes.

Horizon and locality —Miocene; Yorktown, Va.

Geological distribution.—Lower Lias? Tertiary and Recent.

Genus *MILIOLINA* Williamson.

Miliolina seminulum.

Syn. *Serpula seminulum* Linne, Syst. Nat., 12 ed., p. 1264, No. 791, 1767; 13 ed. (Gmelin's), p. 3739, No. 2, 1788.
Miliolina seminulum Williamson, Rec. Foram. Gt. Brit., p. 85, pl. vii, figs. 183-185, 1858.
Miliolina seminulum Brady, Chal. Rep't, vol. ix, p. 157, pl. v, fig. 6, a, b, c, 1884.

Test free, calcareous, imperforate, elliptical or oblong in outline, consisting of five visible, elongated, smooth segments.

The segments are arranged in an inequilateral way about a Milioline axis. The two outer ones extending the whole length of the shell with their ends overlapping and the aperture a horse shoe-shaped opening, placed in the end of the larger segment.

This species of *Miliolina* was first recognized in the Miocene of St Mary's, Maryland, by Isaac Lea and was described by him under the name *Miliola marylandica* in his Contributions to Geology, 1833, pp. 215, 216, pl. 6, fig. 227, as follows:– "Shell elliptical, depressed in the middle, rounded at the edges, lobes in contact; mouth small, round, terminal, furnished with a large tooth".

In the above description of Mr. Lea no reference is made to the smooth character of the shell or to the number of segments but his figure indicates a smooth form with three segments upon one side and is undoubtedly to be referred to the species *Miliolina seminulum* Linné; length 0.60-0.74 mm., breadth 0.30-0.47 mm.

Horizon and locality.—Miocene; Yorktown, James river, Va.; Jones Wharf, St. Mary's, Md.

Geological distribution.—Eocene to Recent.

Genus *LAGENA* Walker and Boys.

Lagena globosa.

Syn. *Vermiculum globosum* Montagu, Test. Brit., p. 523, 1803.
Lagena globosa, Brady, Chal. Rep't., vol. ix, p. 452, pl. lvi, figs. 1, 2, 3, 1884.

Test subglobular, elliptical or pyriform, smooth, anterior margin somewhat projecting; cell walls thin, hyaline, aperture in an entosolenian neck; length 2.00 mm., breadth 1.50 mm.

Horizon and Locality.—Pleistocene; Cornfield Harbor, Md. Not common.

Genus *NODOSARIA* Lamarck.

Nodosaria aculeata.

Syn. *Nodosaria aculeata* d'Orbigny, Foram. Foss. Vien., p. 35, pl. 1, figs. 26, 27, 1846.

Test rather small, short and stoutly built; primordial end bluntly rounded, anterior large and bulbous, prolonged into a tubular neck which carries the aperture; segments five in number, short, only slightly constricted, surface very thickly covered with spines which project straight out, or nearly so, from the surface.

This interesting species should perhaps be considered as identical with *Nodosaria hispida* d'Orbigny, but typical forms of the latter are always deeply constricted at the nodes and sometimes the chambers are entirely separated and are then connected by stoloniferous tubes, while the segments of *Nodosaria aculeata* are almost flush at the sutures.

Horizon and locality.—Miocene; Norfolk, Va. Well boring, depth 665 feet.

Nodosaria affinis.

Syn. *Nodosaria affinis* d'Orbigny, Foram. Foss. Vien., p. 39, pl. 1, figs. 36–39, 1846.

Nodosaria affinis Sherborn and Chapman, Jour. Roy. Microsc. Soc., ser. 2, vol. vi, p. 748, pl. xiv, fig. 33, 1886.

Test very large, nearly straight, more tapering than *Nodosaria bacillum* and without having the primordial chamber larger than the succeeding one; proximal end acuminate; chambers numerous, unconstricted below but becoming distinctly so above; surface marked by about ten distinct elevated costæ as in *Nodosaria bacillum*; aperture central, elevated on the ultimate chamber; length 9.00 mm. or more.

Horizon and locality.—Eocene; Woodstock, Va.

Geological distribution.—Tertiary.

Nodosaria bacillum.

Syn. *Nodosaria bacillum* Defrance, Dict. Sci. Nat., vol. xxxv, p. 127; vol. xxxvi, p. 487, Atlas Conch., pl. xiii, fig. 4, 1825.

Nodosaria bacillum Bagg, Johns Hopkins Univ. Circulars, vol, xv, p. 5, 1895.

Test very large, straight or nearly so, surface marked by about ten very distinct snow-white costæ, though the number does not remain constant, some specimens having only eight costæ below and as many as twelve above; primordial chamber bulbous, acuminate, though with the spine usually broken; segments regular, less distinct below, marked by straight transverse septa; length, fragments of nine chambers measure five mm.

Horizon and locality.—Eocene; Woodstock, Va.

Geological distribution.—Tertiary.

Nodosaria communis.

Syn. *Dentalina communis* d'Orbigny, Mem. Soc. geol. France, vol. iv, p. 13, pl. 1, fig. 4, 1840.
Nodosaria communis Bagg, Johns Hopkins Univ. Circulars, vol. xv, p. 5, 1895.

Test elongate, smooth, with depressed oblique septa; primordial chamber larger than the one succeeding and in our specimen acuminate; ultimate chamber elongate, tube-like; transverse section circular; aperture round, smooth; length 0.60 mm.

Nodosariæ are very rare in the Miocene of Maryland and I have only one specimen of the above species. It possesses but three chambers and is undoubtedly a young form.

Horizon and locality.—Eocene; Sunnyside, Md.

Geologicul distribution.—Permian to Recent.

Nodosaria consobrina, var. emaciata.

Syn. *Nodosaria consobrina* var. *emaciata* Reuss, Denkschr. Akad. Wiss. Wien., vol. xxv, p. 132, pl. ii, figs. 12, 13, 1865.

Test smooth, elongate, tapering, segments numerous, short, elongate-oval; similar to *Nodosaria consobrina* but more elongated and slender; septa somewhat depressed, transverse. The proximal chamber is rounded and ends in a nipple-shaped aperture.

Horizon and locality.—Eocene; Marlboro, Md.

Nodosaria farcimen.

Syn. *Orthoceras farcimen* Soldani, Testaceographia, vol. i, pt. 2, p. 98, pl. cv, fig. o., 1791.
Nodosaria farcimen Brady, Chal. Rep't, vol. ix, p. 498, pl. lxii, figs. 17, 18; (woodcuts, fig. 13, a, b, c,).

Test smooth, arcuate, tapering, with from six to ten inflated segments separated by deep, straight, transverse sutures. The latter feature separates this species from *Nodosaria communis* in which the sutures are oblique. There is also an irregularity in the increase of the size of the chambers noticeable in most specimens. Ultimate chamber prolonged into a round tube which bears the oral opening; length 2.82 mm. (Cretaceous), 1.10 mm. (Eocene).

Specimens of the above species from the Cretaceous of New

Jersey are much larger and show less regularity in the size of the chambers. The small Eocene specimens are not very common.

Horizon and locality.—Eocene; Pamunkey river, Va.

Geological distribution.—Permian to Recent.

Nodosaria obliqua.

Syn. *Nautilus obliquus* Linne, Syst. Nat., 12 ed., p. 1163, 281, 1767 ; ibid, 13 ed. (Gmelin's), p. 3372, No. 14, 1788.
Nodosaria obliqua Brady, Chal. Rep't, vol. ix, p. 513, pl. lxiv, figs. 20-22, 1884.

Test variable in size, sometimes very large, elongate, tapering, arcuate; septal lines depressed, surface costate, costæ varying in size and number in different specimens; chambers numerous, ventricose, distinct; aperture central, radiate.

The few specimens we have of this species are rather short and stoutly built like *Dentalina confluens* Reuss, which form they are identical with, the latter being a variety of this exceedingly variable species.

Locality.—Norfolk, Va. Well-boring, depth 685 feet.

Geological distribution.—Lias to Recent.

Genus *VAGINULINA* Lamarck.

Vaginulina legumen.

Syn. *Nautilus legumen* Linne, Syst. Nat., 10th Ed., p. 711, No. 248, 1758; 12th Ed., p. 1164, No. 288, 1767.
Vaginulina legumen Bagg, Johns Hopkins Univ. Circulars, vol. xv, p. 5, 1895.

Test nearly straight, pod-like, compressed, smooth, consisting of only six chambers; septa limbate, parallel, oblique, less distinct towards the distal end; ultimate chamber slightly prolonged at the anterior end; aperture radiate; length 0.80 mm.

Horizon and locality.—Eocene; Sunnyside, Md.

Geological distribution.—Trias to Recent.

Genus *CRISTELLARIA* Lamarck.

Cristellaria cultrata.

Syn. *Robulus cultratus* Montfort, Conch. Syst., vol. i, p. 214, 54 genre, 1808.
Cristellaria cultrata Parker & Jones, Phil. Trans., vol. clv, p. 344, pl. xiii, figs. 17, 18; pl. xvi, fig. 5, 1865.

Test circular, biconvex, smooth and glistening, margin sharp, broadly keeled; chambers seven to eleven, somewhat convex, smooth or costate; aperture radiate.

Cristellaria cultrata is a common form at several localities in the Upper Cretaceous formations of New Jersey. The width of the marginal keel is very variable though always more or less developed and serves to distinguish this species from *Cristellaria rotulata* which it resembles; geologically it has a wide range, being found as early as the Triassic (Lias) and still existing in present oceans.

Localsty.—Norfolk, Va. Well boring, depth 695 feet.
Crisfield, Md. Well boring, depth 776 feet.

Cristellaria radiata.

Syn. *Robulina radiata* Bornemann, Zeitsch. deutsch. geol. Gesell., vol. vii, p. 334, pl. xv, fig. 1, 1855.
Cristellaria radiata Bagg, Johns Hopkins Univ. Circulars, vol. xv, p. 5, 1895.

Test nearly circular, moderately compressed, with circular, raised umbilicus; final convolution showing ten strongly curved even chambers, marked externally by raised white septal lines which become less distinct towards the peripheral margin; keel quite definite and of the same snow-white color as the raised septa, while the chambers are darker in color and are strongly contrasted with the rest of the shell. The surface is smooth and glistening; the aperture radiate; diameter 1.26 mm.

Horizon and locality.—Eocene; Woodstock, Va., rare.

Geological distribution.—Tertiary.

Cristellaria rotulata.

Syn. *Lenticulites rotulata* Lamarck, Ann. du Museum, vol. v, p. 188, No. 3; Tableau Encyc. et Meth. pl. cccclxvi, fig. 5, 1804.
Cristellaria rotulata Parker & Jones, Phil. Trans., vol. clv, p. 345, pl. xiii, fig. 19, 1865.

Test involute, biconvex, smooth, peripheral margin sharp, non-carinate, chambers numerous, eight or nine in the last convolution; septa moderately curved, visible externally as fine lines; aperture elliptical, radiate.

The genus *Cristellaria* although found so abundantly in the New Jersey Cretaceous seems to be rather rare in the Atlantic SlopeTertiary and is represented by only a few species.

Cristellaria wetherellii.

Syn. *Marginulina wetherellii* Jones, Morris's Cat. Brit. Foss., ed 2, p. 37, 1854.
Cristellaria wetherellii Brady, Chal. Rep't, vol. ix, p. 537, pl. cxiv, fig. 14, 1884.

Test elongate, compressed, pod-like, primordial segments more or less involute, ultimate segments extended into a straight or nearly straight series, surface of shell marked by large tubercles more or less regularly arranged along the septal lines and also upon the chambers of some segments.

Transverse sections are elliptical and show in some forms an angular periphery and when so approaching *Cristellaria decorata* Reuss, in outline. Another closely allied form is seen in *Marginulina hochstetteri* Stache, which has the tubercles developed but lacks the costæ and chamber decoration. Aperture round and situated at the end of a somewhat prolonged neck; length 1.56 mm., breadth 0.50 mm.

This highly ornamented *Cristellaria* was also found by the author in the Cretaceous of New Jersey but it is rare. In the material from the well boring at Crisfield there are many of this species at a depth of 776 feet.

Horizon and locality.—Miocene?; Crisfield, Md. Well boring; depth 776 feet.

Geological distribution.—Cretaceous to Recent.

Genus *POLYMORPHINA* d'Orbigny.

Polymorphina amygdaloides.

Syn. *Polymorphina amygdaloides* Reuss, Sitzungsb. Akad. Wiss. Wien, vol. xviii, p. 250, pl. viii, fig. 84, 1855.

Polymorphina amygdaloides Bagg, Bull. U. S. Geol. Surv., No. 141, p. 91, 1896.

Test ovoid, flatly compressed upon one side, somewhat covex upon the other; anterior end acute, posterior obtusely rounded; chambers three or four elongated, alternating, not all equally depressed, septal lines somewhat depressed, especially the longest. The surface is smooth and glistening; length 0.35 mm.

The above form is not typical for the species, being more unsymmetrical than usual owing to the prominence of one of the lateral chambers. According to Messrs. Brady, Parker and Jones, this species is very variable in form and includes such varieties as *Polymorphina minuta* Rœmer, *Polymorphina guttula* Reuss, *Polymorphina depauperata* Reuss, etc.

Horizon and locality.—Eocene; Pamunkey river, Va.

Geological distribution.—Tertiary to Recent.

Polymorphina austriaca.

Syn. *Guttulina austriaca* d'Orbigny, Foram. Foss. Vien., p. 223, pl. xii, figs. 23-25, 1846.

Polymorphina austriaca Bagg, Johns Hopkins Univ. Circulars, vol. xv, p. 5, 1895.

Test oviform, smooth, moderately compressed, acuminate anteriorly, consisting of four chambers which are oblong, oblique and somewhat convex, separated by fairly deep sutures; aperture mammillate.

d'Orbigny considers that *Guttulina nitida* is closely related to this species but states that it differs from it in the more elevated chambers. Our specimens are slightly more acute posteriorly than d'Orbigny's figure.

Horizon and locality.—Eocene; Woodstock, Va.

Geological distribution.—Tertiary.

Polymorphina communis.

Syn. *Guttulina communis* d'Orbigny, Ann. Sci. Nat., vol. vii, p. 266, No. 15, pl. xii, figs. 1-4; Modele, No. 62, 1826.

Polymorphina communis Bagg, Bull. U. S. Geol. Surv., No. 141, p. 92, 1896.

Test irregular ovoidal, or egg-shaped, consisting of four or five distinct segments; anterior extremely acute, posterior obtuse; chambers inflated, elliptical, embracing; surface smooth with distinct septal depressions; aperture mammillate; diam. 0.35 mm.

This species occurs quite abundantly in the New Jersey Cretaceous but the forms are much larger than in the Eocene of Maryland.

Horizon and locality.—Eocene; Woodstock, Va.; Pamunkey river, Va.

Geological distribution.—Lias to Recent.

Polymorphina complanata.

Syn. *Polymorphina complanata* d'Orbigny, Foram. Foss. Vien., p. 234, pl. xiii, figs. 25-30, 1846.

Test complanate, elongate, resembling *Frondicularia* in outline, chambers numerous, arranged biserially; anterior end acute, posterior obtusely rounded, lateral margins rounded, nearly parallel; septal lines depressed, slightly oblique and alternating; chambers somewhat lobed at the margin and elevated but not strongly so; surface smooth; aperture mammillate; length 1.73 mm., breadth 0.50 mm.

Horizon and locality.—Eocene; Pamunkey river, Va.

Geological distribution.—Cretaceous and Tertiary.

Polymorphina compressa.

Syn. *Polymorphina compressa* d'Orbigny, Foram. Foss. Vien., p. 233, pl. xii, figs. 32-34, 1846.

Polymorphina compressa Brady, Parker and Jones, Trans. Linn. Soc., London, vol. xxvii, p. 227, pl. xl, fig. 12, a-f, 1870.

"Shell oblong, inequilateral, compressed, more or less fusiform: chambers numerous, arranged in two inequal series, somewhat inflated; septal lines depressed; surface smooth or faintly striated; aperture variable, usually simple, circular, coronate; sometimes labyrinthic or porous"; length, from one twentieth to one tenth of an inch; (Brady, Parker and Jones, loc. cit.); length 0.82-1.30 mm., breadth 0.43 mm.

This species is very common in the Maryland Miocene beds especially at Plum Point, Jones Wharf, Md., and also occurs in the bluffs on the James river, Va.

Horizon and locality.—Eocene; Woodstock, Va. Miocene; Plum Point, Md., Norfolk, Va. Well boring; depth, 685 feet.

Geological distribution.—Lias to Recent.

Polymorphina elegantissima.

Syn. *Polymorphina elegantissima* Parker & Jones, Phil. Trans., vol. clv, table x, p. 438, 1865.

Polymorphina elegantissima Brady, Parker & Jones, Trans. Linn. Soc., London, vol. xxvii, p. 231, pl xl, fig. 15 a-c, 1870.

Test ovoidal, anterior end acute, posterior obtusely rounded; chambers four or five, elongate, arranged in an inequilateral biserial manner and overlapping in such a way that while one side remains nearly flat the opposite is more or less irregularly vaulted and shows all the chambers in parallel arrangement; final segment broad below, embracing, and bearing the mammillate aperture upon the anterior end. Shell surface smooth, finely perforate; length 0.60 mm., breadth 0.40 mm.

Prof. Brady considers that *Polymorphina problema* var. *deltoidea* Reuss, and *Polymorphina anceps* Reuss, are identical with this species.

Horizon and locality.—Eocene; Woodstock, Va.

Geological distribution.—Eocene to Recent.

Polymorphina gibba.

Syn. *Globulina gibba* d'Orbigny, Foram. Foss, Vien., p. 227, pl. xiii, figs. 13, 14, 1846.

Polymorphina gibba Bagg, Johns Hopkins Univ. Circulars, vol. xv, p. 5, 1895.

Test subglobular, apex slightly produced, base obtusely rounded, consisting of from two to four chambers compactly joined and overlapping. The surface is smooth and unmarked by septal constrictions. Septa are visible as delicate, oblique lines; transverse section nearly circular; aperture mammillate; length 0.35 mm., breadth 0.30 mm.

Specimens of the above species from the Eocene of Maryland are very similar to those from the Navesink formation (lower marl bed) of New Jersey, but the Eocene forms are much smaller. It is not a common species in the Eocene.

Horizon and locality.—Eocene; Woodstock, Va.

Geological distribution.—Jurassic to Recent.

Polymorphina lactea.

Syn. *Serpula lactea* Walker and Jacob, (fide Kanmacher's Ed.), Adams Essays Microsc. p. 634, pl. xiv, fig. 4, 1798.

Polymorphina lactea Brady, Parker and Jones, Trans. Linn. Soc. London, vol. xxvii, p. 213, pl. xxxix, fig. 1, a-c, 1870.

Test ovate or subpyriform, only slightly compressed, consisting of three or four chambers with flush sutures and scarcely distinct septal lines; aperture terminal, radiate; diam. 0.39 mm.

Horizon and locality.—Miocene, Plum Point, Md.

Geological distribution.—Jurassic to Recent. Not common.

Polymorphina prælonga.

Syn. *Polymorphina prælonga* Terquem, Mem. Soc. geol. France, ser. 3, vol. i, p. 39, pls. iii, viii, figs. 20, 21; 1878.

Polymorphina prælonga Bagg, Johns Hopkins Univ. Circulars, vol. xv, p. 5, 1895.

Test elongate-oval, attenuated anteriorly; smooth and glistening, nearly circular in transverse section; three or four slightly raised, elongate chambers, marked by somewhat depressed septa; length 0.79 mm.

This species with its many varieties is beautifully illustrated in Terquem's monograph on the Eocene Foraminifera of Paris. According to that author this species is more abundant in the Eocene, being quite rare in deposits of Pliocene age.

Horizon and locality.—Eocene; Woodstock, Va.

Geological distribution.—Eocene to Pliocene.

Genus *UVIGERINA* d'Orbigny.

Uvigerina canariensis.

Syn. *Uvigerina canariensis* d'Orbigny, Foram. Canaries, p. 138, pl. 1,

figs. 25-27, 1839.
Uvigerina urnula d'Orbigny, Foram. Foss. Vien., p. 189, pl. xi, figs. 21-22, 1846.

The test of *Uvigerina canariensis* is characterized by its smooth shell although faint indications of costæ are sometimes seen in recent specimens and in the form described by d'Orbigny under the name *Uvigerina urnula* from the Miocene of the Vienna Basin. The shell is in the form of an irregularly built triserial spire of various length, and ends in a more or less elongated tube with a flaring aperture.

The segments are more or less globose and distinct, the suture being well marked; length 0.57 mm.

Horizon and locality.—Miocene?; Crisfield, Md. Well boring; depth, 776 feet.

Geological distribution.—Miocene to Recent.

Uvigerina pygmæa.

Syn. *Uvigerina pygmæa* d'Orbigny, Ann. Sci. Nat., vol. vii, p. 269, pl. xii, figs. 8, 9, 1826. Modele, No. 67.
Uvigerina pygmæa Parker and Jones, Phil. Trans., vol. clv, p. 363, pl. xiii, figs, 53-7; xvii, fig. 65, 1865.

Test more or less broadly ovate and stoutly built, with thick shell-wall. The chambers are numerous, large and globose, and are separated by depressed septal lines. The surface is marked by a number of prominent longitudinal costæ which are less numerous and larger than in the longer and more tapering *Uvigerina tenuistriata* Reuss. The primordial end is rounded, the anterior extended into a short tubular neck with a flaring aperture.

This interesting little species occurs very abundantly in the samples of greensand from the well boring at Norfolk, Va., and is not rare in the boring at Crisfield, Md.

Horizon and locality.—Miocene; Norfolk, Va. Well boring; depth, 645 to 685 feet. Occurs also at Crisfield, Md., in a deep artesian well boring.

Geological distribution.—Miocene to Recent.

Uvigerina tenuistriata.

Syn. *Uvigerina tenuistriata* Reuss, Sitzungsb. Akad. Wiss. Wien., vol. lxii, p. 485, pt. 1; von Schlicht, Foram. Septar. Pietzpuhl, pl. xxii, figs. 34-37, 1870.

Test much more finely striate than *Uvigerina pygmæa* and more slender, tapering to a small well rounded end below and gradually increasing in size above. The chambers are not so globose and the septa are not so depressed as in *Uvigerina pygmæa*. Aperture at the end of a flaring tubular neck as in typical *Uvigerina* forms.

The above species is less common than the allied form *Uvigerina pygmæa*.

Horizon and locality.—Miocene; Norfolk, Va. Well boring, depth 645 to 685 feet. It also occurs in the artesian well boring, Crisfield, Md.

Geological distribution.—Upper Oligocene to Recent.

Genus *GLOBIGERINA* d'Orbigny.

Globigerina bulloides.

Syn. *Globigerina bulloides* d'Orbigny, Ann. Sci. Nat., vol. vii, p. 277, No. 1, 1826. Modele's No. 17, (young) and No. 76.

Globigerina bulloides d'Orbigny, Foram. Foss. Vien., p. 163, pl. ix, figs. 4-6, 1846.

Globigerina bulloides Brady, Chal. Rep't, vol. ix, p. 593, pl. lxxvii, and pl. lxxix, figs. 3-7, 1884.

"Test spiral, subtrochoid; superior surface convex, inferior more or less convex but with deeply sunken umbilicus, periphery rounded, lobulated; adult specimens composed of about seven globose segments, of which four form the outer convolution, the aperture of the individual chambers opening independently into the umbilical vestibule; diameter sometimes one fortieth of an inch (0.63 mm.), but oftener much less." (Brady, loc. cit.)

Globigerina bulloides is not an unusual form in the Miocene of Virginia but it is more abundant at Plum Point, Maryland than elsewhere.

Horizon and locality.—Eocene; Woodstock, Va. Miocene; Darlington, S. C., James river and Yorktown, Va., Plum Point, Maryland.

Geological distribution.—Cretaceous to Recent.

Genus *SPIRILLINA* Ehrenberg.

Spirillina orbicularis, n. sp.

Test free, consisting of a non-septate tube coiled in a planospiral manner and forming in our specimen about seven convolutions. The peripheral margin is broadly rounded. The lateral surfaces are unlike, upon one the inner side of the coils are marked by a large number of elliptical pits while the opposite is somewhat granulated and apparently without the depressions. The final convolution ends in a constricted aperture, slightly eccentric; diam. 0.52 mm.

The above species resembles *Spirillina margaritifera* Williamson with this difference that in place of tubercles we have depressions. I have only one specimen of this interesting form but it is perfect and I have no hesitation in pronouncing it to be new.

Horizon and locality.—Miocene; Yorktown, Va.

Genus *DISCORBINA* Parker & Jones.

Discorbina bertheloti.

Syn. *Rosalina bertheloti* d,Orbigny, Foram. Canaries, p. 135, pl. 1, figs. 28-30, 1839.

Discorbina bertheloti Bagg, Bull. U. S. Geol. Surv., No. 141, p. 92.

Test very compressed, carinate, finely punctate; spiral side approximately flat, reverse side low-convex; chambers depressed, convex, numerous, margins slightly limbate; ultimate chamber larger than the one preceding. The shell is quite similar to *Truncatulina lobaluta*, but it is more depressed and the walls are more finely perforate; diam. 0.42 mm.

Horizon and locality.—Eocene; Woodstock, Va.

Geological distribution.—Cretaceous to Recent.

Discorbina orbicularis.

Syn. *Rosalina orbicularis* Terquem, Anim. sur la Plage de Dunkerque, pt. 2, p. 75, pl. ix, fig. 4, a, b, 1876.

Discorbina orbicularis Brady, Chal. Rep't, vol. ix, p. 647, pl. lxxxviiii, figs. 4-8, 1884.

Test small, nearly circular, superior side convex, inferior depressed at the umbilicus and slightly concave; peripheral margin sharp.

The superior chamber shows numerous, very much elongated chambers which extend nearly half way around the shell as they reach the peripheral margin. Upon the inferior side only three or four segments are visible and these are marked by very slight septal depressions. The aperture is in the form of an elongated slit reaching from the margin to near the umbilicus upon the inferior surface.

Diam., 0.39.

I have only one specimen of this minute shell.

Horizon and locality.—Miocene; Darlington, S. C.

Geological distribution.—Miocene to Recent.

Genus *TRUNCATULINA* d' Orbigny.

Truncatulina haidingerii

Syn. *Rotalina haidingerii* d'Orbigny, 1846, Foram, Foss, Vien., p. 154, pl. vii, figs. 7--9.

Rotalina ehrenbergii Bailey, Smithsonian Contrib. to Knowl., vol. 11, Art. 3, p. 10, figs. 11--13, 1851.

Truncatulina haidingerii Brady, Chal. Rep., vol. IX, p. 663, pl. xcv, fig. 7, a--c, 1884.

Test circular, biconvex, trochoid, composed of three volutions. Upon the inferior side the chambers are marked by nearly straight somewhat depressed septa, while upon the superior side the septa are more or less curved backward, often quite strongly so. The aperture is in the form of a very small slit near the periphery.

This species is very similar to *Truncatulina ungeriana* but differs from it in being more vaulted and less depressed at the umbilicus. There is no distinct groove following the whorls upon the superior side and the perforations are much smaller than in its allied form.

Our forms of this species from the well boring at Norfolk, Va., found at a depth of 685 feet are of Tertiary age (lower?) and are identical with *Rotalia propinqua* Reuss, which must be considered as a synonym of *Truncatulina haidingerii* d'Orbigny.

Horizon and locality.—Norfolk, Va. Well boring, depth 685 feet.

Geological distribution.—Cretaceous to Recent.

Truncatulina lobatula.

Syn. *Nautilus lobatulus* Walker & Jacob, 1798, (fide Karmacher's Ed.) Adams Essays Microsc, p. 642, pl. xiv, fig. 36.

Truncatulina lobatula Brady, Chal. Rept., vol. ix, p. 660, pl. xcii, fig. 10, pl. xciii, figs. 1, 4, 5; pl. cxv, figs. 4, 5, 1884.

Test plano-convex, moderately vaulted; last volution consisting of seven, eight, or nine chambers with slightly depressed septa; septal lines being more curved on the superior surface. Aperture a small neatly shaped arch at the inferior margin of the ultimate segment.

Diameter, 0. 6 mm.

The above species shows great variation. Professor Brady considers that the more convex varieties merge into *Truncatulina refulgens*, while flattened forms resemble *Truncatulina wuellerstorfi*. The regularly built convex varieties constitute the *Truncatulina boueana* d'Orbigny, while the less regular are equivalent to *Truncatulina variabilis* of the same author. The latter species is well represented in the very irregular wide spreadings forms from Plum Point, Md.

Horizon and locality.—Eocene; Woodstock, Va.: Miocene; James River, Yorktown, and Norfolk, Va.; Plum Point, and Jones Wharf, Md.

Truncatulina variabilis.

Syn. *Truncatulina variabilis* d'Orbigny, Ann. Sci. Nat., vol. VII, p. 279, No. 8, 1826.

Truncatulina variabilis Terquem, Mim. Soc. Geol. France, ser. 3, vol. II, Mem. III, p. I, figs, 18--25, 1878.

Test consisting of a depresssd, plano-convex, exceedingly variable form, the segments of which are never uniform or regular in arrangement as in *Truncatulina lobaluta* but are more or less evolute in shape and the amount of depression. The surface of the shell is coarsely perforate. Aperture a wide gaping arch extending along the inner margin of the final convolution.

Diameter, 0.56—1 mm.

Horizon and locality.---Miocene; Plum Point, Jones Wharf, Md.

Geological distribution.—Eocene to Recent.

Genus *PULVINULINA* Parker & Jones.

Pulvinulina elegans.

Syn. *Rotalia elegans* d'Orbigny, Ann. Sci. Nat. vol. VII, p. 276, No. 54, 1826.

Pulvinulina elegans Brady, 1884, Rept. Chal., p. 699, pl. CV, figs. 4--6.

Test large, orbicular, both sides convex, but more so upon the inferior side; surface rough, marked especially upon the inferior side by raised tubercles; peripheral margin sharp, slightly carinate. The chambers are arranged in three convolutions which are all visible upon the superior side and separated by curved band-like septa. Only faint irregular depressions of septal lobes indicate the chambers of the final volution upon the inferior surface. The septal lobes are not curved as upon the superior side; aperture variable and sometimes invisible. Some forms show a very small semi-lunar arch upon the lower surface.

Diam., 0.52--0.65 mm.

This little *Pulvinulina* is the most common form to be found in the Eocene of Pamunkey river and shows great variation in size and form.

Some specimens are plano-convex while others are distinctly bi-convex. Transverse sections show the same nummuline lamination as shown in figure 21(woodcut) of the Challenger Report. The Jurassic *Epistomina* of Dr. Uhlig (Jahrb. k. k. Geol. Reichsanstalt, vol. XXIII, p. 770, pl. VII, fig. 10 and pl. VIII. figs, 1—3,) are very similar to our specimens but the aperture does not appear to be the same. According to Professor Brady this species is almost identical with *Pulvinulina partschiana* d'Orbigny for he states that "The *Rotalia elegans* of the 'Tableau Methodique, founded upon figures in Soldani's 'Testaceographia' passes by insensible gradations into the *Rotalina partschiana* of the Vienna Basin memoir. The particular variety represented by the former figure attains larger dimensions, the test is less convex and therefore relatively thinner, and the septa are marked by broad, clear lines, neither elevated nor depressed, whilst in the latter the sutures, especially on the inferior face, are generally more or less limbate externally."

This author further states that *Pulvinulina elegans* occurs in comparatively shallow water while *Pulvinulina partschiana* is a deep water form.

Horizon and locality.—Eocene; Pamunky river, Va.

Geological distribution.—Jurassic to Recent.

Pnlvinulina schreibersii.

Syn. *Rotalina schreibersii* d'Orbigny, 1846, Foram. Foss. Vien., p. 154, pl. VII, figs. 4—6.
Pulvinulina schreibersii Bagg, Johns Hopkins Uuiv. Circulars, vol. XV, p. 5, 1895.

Test orbicular, superior side more convex than inferior; consisting of about seven chambers in final convolution, (some specimens show nine); inferior side distinctly stellate with depressed septal lines and elevated chambers, the latter feature being characteristic for the species, and distinguishing it from *Pulvinulina karsteni* by lack of peripheral keel. The final chamber is larger and more globose than the one adjoining; umbilicus depressed on inferior side; aperture a submarginal slit.

Diameter, 0. 4—0.54.

This species is not uncommon in the Eocene of Woodstock but seems to be quite rare in the Miocene of James river, Va.

Professor Brady does not mention this species as occurring back of the Miocene but states that it is common in the late Tertiaries of Europe.

Horizon and locality.—Eocene; Woodstock, Va.: Miocene; James river, Va.

Geological distribution.—Eocene to Recent.

Genus *ROTALIA* Lamarck.

Rotalia beccarii.

Syn. *Nautilus beccarii* Linne, 1767, Syst. Nat., Ed. 12, p. 1162; 1788, ibid. Ed. (Gmelen's) 13, p. 3370, No. 4.
Rotalia beccarii Williamson, 1858, Rec. Foram. Gt. Brit., p. 48, pl. iv. figs. 90—92.
Rotalia beccarii Parker & Jones, Phil. Trans., vol. clv, p. 388, pl. xvi, figs. 29, 30, 1865.

Test finely porous, formed of a nearly circular low turbinoid spire, peripheral margin lobulated, obtusely rounded; chambers numerous, ten to forty, somewhat inflated, about ten in the final convolution, and separated by depressed nearly straight septal lines. Convolutions about three, inferior surface thickened, and often beaded with exogenous granules at the umbilicus. Aperture a notched, subdivided opening or a series of pores at the inner margin of the ultimate chamber.

Diameter 0.34--0.74 mm.

The above species is a shallow water form and is rather common in the Pleistocene formation at Cornfield Harbor.

Horizon and locality.—Miocene; Darlington, S. C.: Pleistocene; Cornfield Harbor, Md.

Geological distribution.--Miocene to Recent.

Rotalia orbicularis.

Syn. *Rotalia* (*Gyroidina*) *orbicularis* d'Orbigny, Ann. Sci. Nat., vol. VII, p. 278, No. 1;—Modele, No. 13, 1826.
Rotalia orbicularis Terquem, Mem. Soc. Geol. France, ser. 3, vol.

II, Mem. III, p. 60, pl. iv, figs. 1—3, 1882.

Test orbicular, plano- convex or nearly so, superior side being flat, the inferior highly convex and deeply excavated at the umbilicus; peripheral margin subangular, segments numerous separated by curved septa upon the superior side, consisting of three or more convolutions, the inferior side consisting of elevated segments showing a somewhat lobulated margin and with depressed septa.

Professor Brady says of this species "It is isomorphous with *Truncatulina lobatula* in the *Planorbuline* series, and forms a connecting link between *Rotalia beccarii* and *Rotalia soldanii.*"

Horizon and locality.—Miocene; Norfolk, Va.; 685 ft.

Geological distribution.—Eocene to Recent.

Rotalia soldanii.

Syn. *Rotalia* (*Gyroidina*)*soldanii* d'Orbigny, Ann, Sci. Nat., vol. vii, p. 278, No. 5;—Modele, No. 36, 1826.

Rotalia soldanii Hantken, 1875, Mittheil. Jahrb. d. k. ung. geol. Anstalt, p. 80, pl. IX, fig. 7, a—c.

Test plano-convex or nearly so, circular, and with slightly lobulated periphery, superior side showing numerous curved septa, inferior much vaulted, with approximately straight septa which are excavated at the umbilicus.

"The plano-convex habit of growth reaches its extreme development, so far as the present genus is concerned, in *Rotalia soldanii*, the test of which resembles that of *Rotalia orbicularis*, except that the convexity of the inferior side is considerably greater. The species corresponds morphologically to *Truncatulina refulgens* and *Pulvinulina micheliniana*, but the shell is more neatly and compactly built, the outline is more rounded, and the walls more finely perforated than in either of the latter species. Sections of the test show that the septal walls are double, and that there is a considerable deposit of shell-substance in the region of the umbilicus, but without any trace of canals." (Chal. Rept., vol. IX, p. 706.)

Horizon and locality—Miocene; Norfolk, Va. Well boring, depth, 645 ft.

Geological distribution.—Cretaceous; Miocene to Recent.

Genus *NONIONINA* d'Orbigny.

Nonionina affinis,

Syn. *Nonionina affinis* Reuss, Sitz. Ak. Wiss. Wien., vol. III, p. 72,

pl. v, fig. 32, 1851.
Nonionina affinis Bagg, Johns Hopkins Univ. Circulars, vol. xv, p. 5, 1895.

Test small, orbicular, strongly compressed, umbilicate, finely perforate; chambers ten to twelve, small, flat, slightly curved, separated by fairly distinct band-like septal lines; septal plane of ultimate chamber somewhat higher than broad and quite large; aperture short, semilunar.

Diameter, 0.32 mm.

Professor Reuss' figure agrees quite well with our specimen but there are twelve chambers visible in the last volution. According to Reuss this species is closely related to *Nonionina punctata* d'Orbigny, but the latter species is thicker in transverse section.

Horizon and locality.—Eocene; Woodstock, Va.

Geological distribution.—Cretaceous and Tertiary.

Nonionina boueana.

Syn. *Nonionina boueana* d'Orbigny, 1846, Foram. Foss. Vien., p. 108, pl. v, figs. 11, 12.
Nonionina boueana Brady, Chal. Rept, vol. IX, p. 729, pl. CIX, figs. 12, 13, 1884.

Test broadly oval, strongly compressed laterally, peripheral margin sharp angled, segments numerous, usually about ten or twelve in the last volution, long, narrow, with slight lobulated margin separated by distinct septa somewhat curved especially toward the younger chambers; umbilicus depressed; separated from *Nonionina scapha* by its sharp peripheral margin and more numerous chambers. Aperture a small, arched opening on the inner margin of the septal plane.

Horizon and locality.—Miocene; Norfolk, Va. Well boring, depth, 645 feet.

Geological distribution.—Upper Oligocene to Recent.

Nonionina depressula.

Syn. *Nautilus depressulus* Walker & Jacob, 1798, Adams' Essays Microsc., Kanmacher's Ed., p. 641, pl. XIV, fig. 33.
Nonionina depressula Brady, Chal. Rept., vol. IX, p. 725, pl. CIV, fig. 6, 7, 1884.
Nonionina depressula Bagg, Johns Hopkins Univ. Circulars, vol. xv, p. 5. 1895.

Test strongly depressed, convolute, peripheral edge round; chambers numerous, ten to twelve in the last volution, slightly curved septa; septal lines distinct and but faintly depressed, becoming more nearly straight as they approach the ultimate chamber. Umbilical area granulated, nearly flush with the general surface of the shell. Shell-wall thin and hyaline. Aperture a narrow elongated slit.

Diameter, 0.26 to 0.34 mm.

Professor Brady considers this shallow water form as a starved variety of its allies the home of which is in water of less than fifty fathoms, and whose distribution is almost universal.

Horizon and locality—Eocene; Pamunkey river, Va.: Miocene; Yorktown, Va.

Geological distribution.—Eocene to Recent.

Nonionina scapha.

Syn. *Nautilus scapha* Fichtel & Moll, 1803, Test. Micr., p. 105, pl. XIX, figs. d--f.

Nonionina scapha Brady, Chal. Rept., vol. IX, p. 730, pl. CIX, figs. 14, 15, and 16?, 1884.

Test free, hyaline, finely perforate, elongate, rather strongly compressed, peripheral margin broadly rounded, chambers numerous, narrow and long, rapidly increasing in size toward the ultimate chamber and separated by nearly straight septal lines which are only slightly depressed. The ultimate chamber is the largest and longest, extending fully two-thirds the length of the shell. The septal plane is broadly oval or somewhat cordate; convolutions about three; twelve to fourteen chambers in the last volution, aperture a small concentric shaped median slit at the inner margin of the final segment.

Length, 0.39—0. 65 mm.

Breadth, 0.3—0.47 mm.

This a common form in the Miocene.

Horizon and locality.—Miocene; James river, Yorktown, Va. Plum Point, Md.

Geological distribution.—Miocene to Recent.

Polystomella striatopunctata.

Syn. *Nautilus striatopunctata* Fichtel & Moll, 1803, Test. Micr., p. 61, pl. IV, figs. a--c.

Polystomella striatopunctata Brady, Chal. Rept., vol. IX, p. 733, pl. CIX, figs. 22, 23.

Test rounded, both sides equally compressed, peripheral margin obliquely rounded, becoming somewhat lobulated near the ultimate chamber; segments triangular, ten in the last volution, separated by straight, slightly depressed septal lines which are in the shape of bridges marking the retral process of the shell; umbilicus very slightly depressed, septal plane nearly round, aperture in the form of a series of pores or openings along the inner margin of the ultimate segment.

Diameter, 0.26--0.78 mm.

Horizon and locality.—Pleistocene; Cornfield Harbor, Md.

Geological distribution.—This beautiful little *Polystomella* of variable size is the most abundant species in the Pleistocene deposit at Cornfield Harbor.

Genus *AMPHISTEGINA* d'Orbigny.

Amphistegina lessonii.

Syn. *Amphistegina lessonii* d'Orbigny, (parte) Ann. Sci. Nat., vol. VII. p. 304, No. 3, pl. xvii, figs. 1--4, 1826.
Amphistegina lessonii Brady, Chal. Rept., vol. ix, p. 740, pl. cxii, figs. 1--7, 1884.
Amphistegina lessonii Bagg, Johns Hopkins Univ. Circulars, vol xv, p. 5, 1895.

Test circular, compressed, transverse section elliptical; superior side only slightly more elevated than the inferior; superior surface shows about eighteen angular segments; inferior surface less distinctly chambered, more irregular; chambers narrow, angular, visible in transmitted light; surface smooth, of a brownish yellow color.

Diameter, 1.47--2 mm.

According to Professor Brady this species shows great variation in the amount of convexity. Our specimens agree more closely with his figure 4 of plate cvi, in the Challenger Report and may be considered typical for the species.

This is not a common form and only three specimens have been obtained on Potomac creek, and only a few are found in the Miocene of Darlington, nearly all of which are broken.

Horizon and locality.—Eocene; Woodstock, Va.: Miocene; Darlington, S. C.

Geological distribution.—Eocene to Recent.

Summary of Results.

The difference in size between the Cretaceous and Tertiary Foraminifera is very marked, scarcely any of the latter approaching the former in size. Whether this difference is due to the unfavorable conditions for foraminiferal life or because of a difference in the forms of the Foraminifera is not altogether clear;but it seems quite probable that it is due to the greater amount of muddy sediment which is found in the Tertiary beds as compared with the almost pure greensands of the Atlantic Cretaceous.

This difference in sediment points to more shallow water in Tertiary than in Cretaceous time. Greensand at the present day is being deposited at moderate depths in the Gulf of Mexico as was shown by Pourtales. From the investigations of Murray and Renard and others it is sufficiently proven that the production of glauconite seldom takes place at depths greater than 900 fathoms, and generally occurs from 100 to 200 fathoms. This is necessarily the case since usually the greater depths are found too far from the land to allow inorganic materials to reach the place where glauconite would otherwise be deposited, and it has been shown that this inorganic matter in essential for the formation of glauconite. This difference in depth is further substantiated in the Eocene by the great abundance of the shallow water form, *Pulvinulina elegans*; and the absence of its relative, *Pulvinulina partschiana*, which is regarded as a deep water species.

Among the most characteristic genera of the forms identified as belonging particularly to the Eocene may be mentioned *Amphistegina*. The genus *Nodosaria* is represented by only five species none of which are abundant. Cristellarians are also apparently very scarce in the Eocene while the genus *Polymorphina* has a wide representation. The genus *Cyclammina* is of exceptional interest inasmuch as it is considered by Prof. H. B. Brady to be unknown in the fossil state, but that it occurs in beds of Miocene age in New Jersey is proved beyond question by the author who has given the specimens a careful and thorough study.

The shell is finely *arenaceo-siliceous* and hence is unaffected by acids. Its structure is peculiar and quite complex which, together with its large size and flattened form, make the genus easily recognizable.

The following species belonging to the Eocene occur also in the Cretaceous of New Jersey.

Nodosaria communis d'Orbigny.
Nodosaria consobrina var. *emaciata* Reuss.
Nodosaria farcimen Soldani.
Vaginulina legumen Linné.
Polymorphina communis d'Orbigny.
Polymorphina compressa d'Orbigny.
Globigerina bulloides d'Orbigny.
Discorbina bertheloti d'Orbigny.

Among the Miocene species are quite a number which are common to the Cretaceous. These are:

Textularia agglutinans d'Orbigny.
Textularia gramen d'Orbigny.
Textularia sagittula Defrance.
Lagena globosa Montagu.
Nodosaria obliqua Linné; and also those in the Eocene.
Cristellaria cultrata Montfort.
Cristellaria wetherellii Jones.
Cristellaria rotulata Lam.
Polymorphina communis d'Orbigny.
Polymorphina compressa d'Orbigny.
Polymorphina gibba d'Orbigny.
Polymorphina lactea Walker & Jacob.
Globigerina bulloides d'Orbigny.
Discorbina bertheloti d'Orbigny.
Truncatulina haidingerii d'Orbigny.
Truncatulina lobatula Walker & Jacob.

Pelagic species.

One of the subjects brought prominently into notice by the observations taken on the Challenger Expedition is the relation of the surface fauna of the ocean to that of the bottom deposits. So far as the *Foraminifera* are concerned the question is by no means a new one; but the Challenger collections, and those more recently made by Mr. Murray on the cruises of the "Knight Errant" and "Triton", have brought many fresh facts into notice, and furnished new ground for its discussion.

The *Foraminifera* as a rule are not of pelagic habit. On the contrary, by far the larger proportion, probably 98 or 99 per cent. of the known recent "species" or "varieties," including the whole of the porcellanous and arenaceous groups and the bulk of the hyaline forms, inhabit the sand or mud of the sea bottom, and are endowed with no swimming or floating powers. This may be regarded as a well ascertained fact. But on the other hand, there are a certain number of forms belonging to eight or perhaps nine genera, which it is equally certain pass their existence, either in part or entirely at the surface of the ocean or in mid-water. The practical importance of these comparatively few species is due to the extraordinary abundance in which they are found, and the relatively large proportion of the entire mass of the bottom deposit which is made up of their shells.

Table Showing the Distribution of the Foraminifera Described in This Report.

	EOCENE				*MIOCENE*							*PLEISTOCENE*
	Va.		*Md.*		*S. C.*	*Va.*			*Md.*		*N.J.*	*Md*
SPECIES	Pamunkey river	Woodstock	Sunnyside	Marlboro	Darlington	James river	Yorktown	Norfolk	Plum Point	Jones Wharf	Mullica Hill	Cornfield Harbor
	1	2	3	4	5	6	7	8	9	10	11	12
Cyclammina placenta	.	.	.	.	.	.	.	.	.	.	o	.
Textularia abbreviata	.	.	.	.	.	o	o	.	.	.	.	.
" *agglutinans*	.	.	.	.	.	.	.	.	o	.	.	.
" *articulata*	.	.	.	.	.	.	.	.	o	.	.	.
" *gramen*	.	.	.	.	.	o	o	.	.	.	.	.
" *sagittula*	.	.	.	o	.	o	o	.	o	.	.	.
" *subangulata*	.	.	.	.	.	o	.	.	.	.	.	.
Spiroplecta clarki	.	o	.	.	.	.	.	.	.	.	.	.
Bulimina aculeata	.	.	.	.	.	o	.	.	.	.	.	.
" *buchiana*	.	.	.	.	.	.	.	o	.	.	.	.
" *elongata*	.	.	.	.	.	.	o	o	o	.	.	.
Spiroloculina planulata	.	.	.	.	.	.	o	.	.	.	.	.
Miliolina seminulum	.	.	.	.	.	o	o	.	.	o	.	.
Lagena globosa	.	.	.	.	.	.	.	.	.	.	.	o
Nodosaria aculeata	.	.	.	.	.	.	.	o	.	.	.	.
" *affinis*	.	o	.	.	.	.	.	o	.	.	.	.
" *bacillum*	.	o	.	.	.	.	.	.	.	.	.	.
" *communis*	.	.	o	.	.	.	.	.	.	.	.	.

	1	2	3	4	5	6	7	8	9	10	11	12
“ *consobrina*......												
var emaciata...............	.	.	.	o	.	.	.	.	.	.	.	.
“ *farcimen*	o	.	.	.	.	.	.	.	.	.	.	.
“ *obliqua*	.	.	.	.	.	.	.	o	.	.	.	.
Vaginulina legumen.........	.	.	o	.	.	.	.	.	.	.	.	.
Cristellaria cultrata...........	.	.	.	.	.	.	.	o	.	.	.	.
“ *radiata*	.	o	.	.	.	.	.	.	.	.	.	.
“ *rotulata*...........	.	.	.	.	.	.	.	.	.	.	.	o
“ *wetherillii* occurs in a well boring at Crisfield, Md.												
Polymorphina amygdaloides	o	.	.	.	.	.	.	.	.	.	.	.
“ *austriaca*...........	.	o	.	.	.	.	.	.	.	.	.	.
“ *communis*.........	o	o	.	.	.	.	.	.	o	.	.	.
“ *complanata*........	o	.	.	.	.	.	.	.	.	.	.	.
“ *compressa*..........	.	o	.	.	.	o	.	o	o	o	.	.
“ *elegantissima*......	.	o	.	.	.	.	.	.	.	.	.	.
“ *gibba*...............	.	o	.	.	.	.	.	.	.	.	.	.
“ *lactea*...............	.	o	.	.	.	.	.	.	o	o	.	.
“ *prælonga*...........	.	o	.	.	.	.	.	.	.	.	.	.
Uvigerina canariensis.........	.	.	.	.	.	.	.	o	.	.	.	.
“ *pygmæa*	.	.	.	.	.	.	.	o	.	.	.	.
“ *tenuistriata*........	.	.	.	.	.	.	.	o	.	.	.	.
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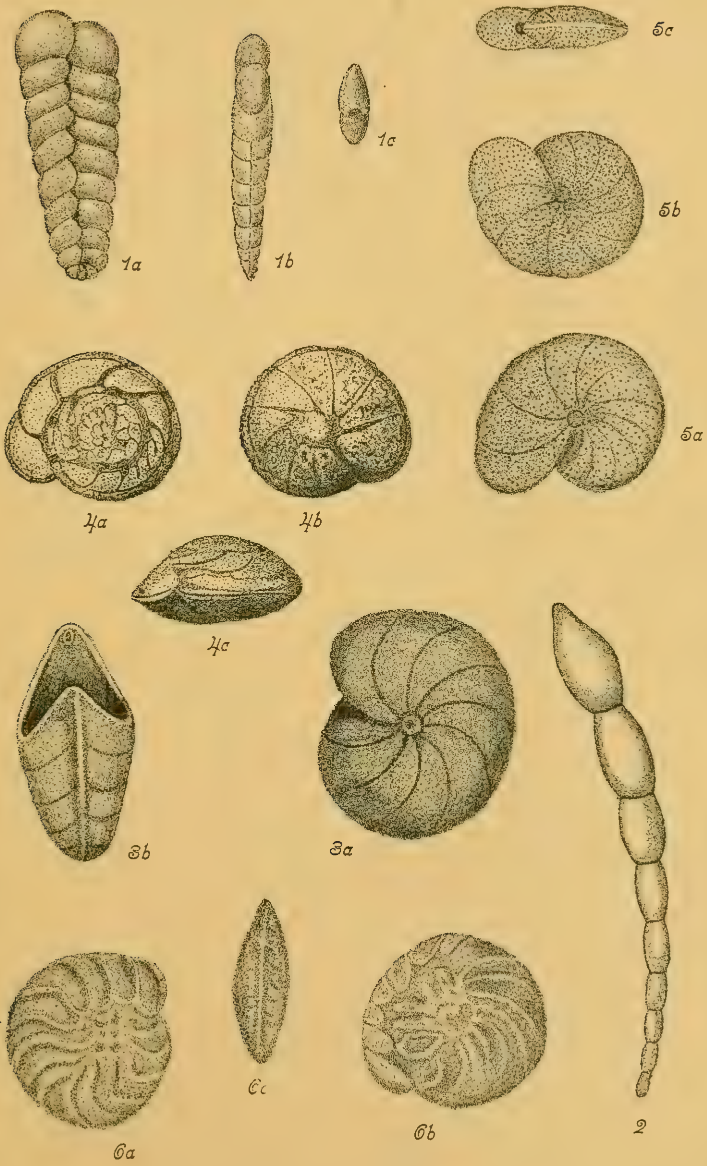
N. B.—The preparation of plates for this Bulletin was in some respects an after-thought; in fact they were not completed until most of the press work was done; hence no reference to them will be found in the text. Their number is however so small that little or no inconvenience will be experienced from this omission.—Ed.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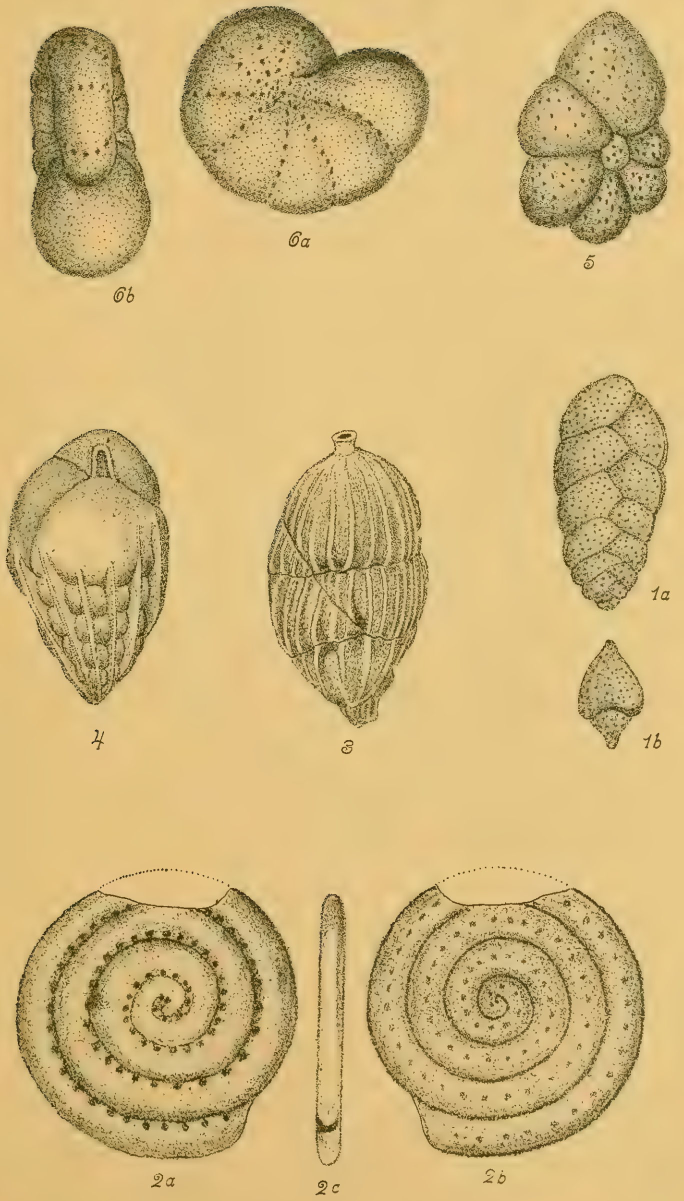
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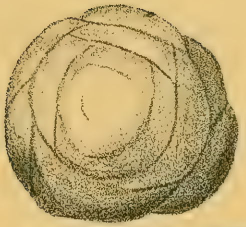
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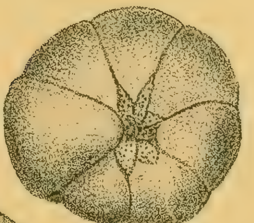
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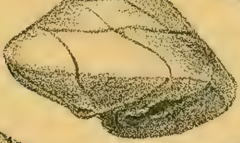
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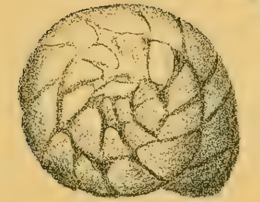
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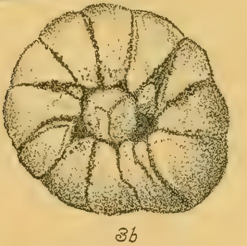
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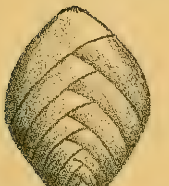
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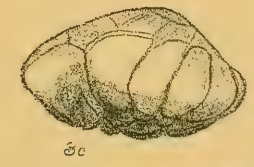
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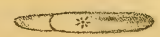
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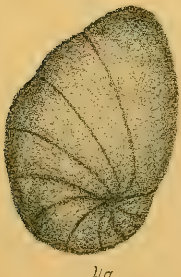
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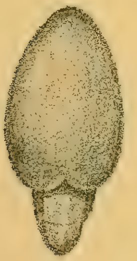
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